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BULLETIN
NEW YORK ZOOLOGICAL SOCIETY



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NATIONAL MUSEUM

Commemorating

A Quarter-Century *of the* New York Aquarium

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A PUBLIC ZOOLOGICAL PARK ⸗ A PUBLIC AQUARIUM ⸗ THE PRESERVATION OF OUR NATIVE ANIMALS ⸗ THE PROMOTION OF ZOOLOGY

VOL. XXXI, No. 1 JANUARY–FEBRUARY, 1928

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FIVE COLOR PHASES OF (*Bodianus fulvus*) THE CONEY

Painted from life in the New York Aquarium by Olive Earle

THIS IS THE SECOND OF A SERIES OF PAINTINGS ILLUSTRATIVE OF INSTANTANEOUS CHANGES IN COLOR AMONG FISHES, WHICH WILL APPEAR REGULARLY IN THE ZOOLOGICAL SOCIETY BULLETIN. THEY ARE TAKEN FROM A WORK ON THIS SUBJECT BY DR. C. H. TOWNSEND, NOW BEING PUBLISHED UNDER THE AUSPICES OF THE ZOOLOGICAL SOCIETY

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

Published by the New York Zoological Society

VOLUME XXXI JANUARY-FEBRUARY, 1928 NUMBER 1

TWENTY-FIVE YEARS OF THE AQUARIUM

By MADISON GRANT

President of the New York Zoological Society

THE close of the year 1927 marks a quarter of a century in the history of the New York Aquarium under the management of the Zoological Society. This number of the Society's BULLETIN may with propriety be devoted to some account of its stewardship.

It was during the administration of Mayor Low in 1902, that the City at the suggestion of Park Commissioner Wilcox, invited the New York Zoological Society to undertake the management of the institution.

The plan agreed upon for its control was similar to that already in operation in the management of other museums in the City. In each of these institutions the direction is placed by the City in the hands of an incorporated association of citizens which provides all exhibits from private funds and undertakes its management, the City furnishing an annual fund for general maintenance and from time to time, improvement of the building. This system of public museum development and control is in operation in certain other cities in this country and in Europe. This method of permanent control by large groups of citizens has resulted in most cases in large private endowments, enabling the various museums in New York to take rank among the most important in the world.

In the case of the New York Aquarium there has followed a gratifying development of the institution in its exhibits, its methods of operation and its relations with the public. The spirit of co-operation between the Zoological Society and the City authorities has been maintained.

When the Aquarium was founded by the City in 1896 the methods of aquarium operation in this country were but little developed. A study of the *modus operandi* in the principal aquariums of Europe by the Director, showed the desirability of changes in equipment which with the co-operation of the City, were gradually effected.

The system of pumping from the harbor was abandoned in favor of the storage of pure sea-water in a reservoir, which resulted in an immediate saving of life among the marine exhibits. This improvement in the supply of sea water was followed by an equally important saving among both marine and fresh-water forms by an increase in the size of the tanks in which they were kept. The increase in water space for living exhibits, made possible an increase in their number and variety.

These changes, accompanied by improvement of the building by the City, led to a decided increase in the number of visitors. The attendance—originally in excess of a million persons a year, increased to an average of two millions. An attendance of fifty millions of persons during the past twenty-five years placed the Aquarium in the lead among the museums of the city in this respect. The number of visitors in 1927 greatly exceeded two millions. The New York Zoological Park has of late enjoyed a similarly large attendance. The two institutions remain in the lead among the public museums of the City in point of patronage by the public. The Aqua-

rium, it may be modestly claimed, "enjoys" a smaller maintenance fund than any of them.

The Aquarium with its never failing interest for the people, has gradually acquired other functions than that of a place for recreation. Many of the services usually demanded of a large public museum, have become part of its work and served to increase the duties of its small staff.

Its relations with the schools and colleges of the City have expanded, many small forms of marine life from the reserve tanks of the Aquarium have long been supplied freely for class-room and laboratory work. Many teachers of biology have small aquaria that are stocked from the surplus of specimens brought in by the Aquarium collecting boat, a vessel owned by the Zoological Society.

An unsolicited correspondence with teachers, investigators and the general public has developed into somewhat troublesome proportions. Numerous pamphlets and circulars relative to aquatic forms of life and the work of the Aquarium are supplied in considerable numbers at little more than cost of publication.

In 1921 the Zoological Society provided from its own funds, the sum of $65,000 for a modern electric pumping plant which was installed in the basement. This important improvement makes possible the construction of additional tanks for new exhibits in the space formerly occupied by machinery. The City has been asked to provide funds for this purpose.

Experiments by the staff of the Aquarium have developed a new system of aeration, by which trout and other cold water fishes are now carried through the warm summer months without any of the losses which always accompanied the old and expensive method of refrigeration. It is understood that other aquariums in this country will adopt our method of safeguarding cold water fishes in warm weather. The methods of management by improved equipment worked out in the New York Aquarium, have led to the preparation by the director, of a work on the subject now being published by the United States Bureau of Fisheries.

Most of the aquariums now in America were largely planned in the New York Aquarium and the Director is regarded as the dean of aquarium men in this country. His long service with the Bureau of Fisheries, his many oceanographic voyages with the *Albatross*, his services on the Bering Sea Fur Seal Commission and as fishery expert at the Court of Arbitrations at the Hague, naturally led to his selection by the Zoological Society for the task of developing the Aquarium. Although this work has necessarily proceeded slowly for lack of funds and lack of space for growth, the Aquarium is now recognized as the leading institution of its kind in the world.

We make no apology for inserting for the first time in the publications of this Society, the Director's photograph and some personal items concerning him.

In connection with administrative duties, Dr. Townsend has found time to publish more than fifty pamphlets on zoological subjects and has lectured and written much on fishery conservation. After his voyage to the Arctic in 1885, he was, if we remember rightly, the first man to suggest the introduction of the domesticated reindeer of eastern Siberia into northern Alaska. Later, when appropriations were being sought for this purpose, he influenced members of congress to vote for them. There are now more than half a million tame reindeer being pastured in north Alaska. The industry is already making important contributions to the supply of fresh meat in the United States and is destined to spread widely over the moss lands of the far north.

The membership of the Zoological Society hardly needs to be reminded that it has been fortunate in the character of the naturalists in its service, both at the Aquarium and the Zoological Park. The past quarter century in the history of the two institutions under its management, inspires high hope for their future usefulness.

We record with regret the death of Dr. C. Kerbert, Director of the Zoological Garden and Aquarium at Amsterdam.

An article by Dr. Kerbert on the habits of the giant salamander of Japan (*Crytobranchus maximus*) was published in a recent number of this BULLETIN.

RECORDS OF COLOR CHANGES AMONG FISHES

II. Five Color-Phases of the Coney (*Bodianus fulvus*)

By CHARLES H. TOWNSEND

GROUPS of this species as received at various times in the past have varied more or less from those collected in 1927, the principal colorations of which the artist has shown here. The color phases described by the writer in 1908* do not correspond in details with those of coneys now in the Aquarium. Few fishes are capable of as many intergradations. Between the two phases showing solid color—the red at bottom, and the dark at upper right of plate II—there are three other distinct phases that are assumed naturally. Persistent annoyance by the observer's assistant, such as driving the fishes from one hiding place to another, will also produce them in varying degrees of intensity.

Individual coneys indulging in frequent changes when first placed in the tanks, may later take to a single coloration and maintain it habitually with but little temporary alteration. Such fishes are inclined to select a comfortable situation among the rockwork—sometimes head downward in a crevice—and may be found there day after day. Others may be more active, some of them fighting until their jaws are lacerated and unsightly. Hostile coneys hang bull-dog like to each other's jaws and after exhausting struggles, return to fight again. Their colors when fighting are different from those displayed at other times and the artist did not feel equal to the task of recording them.

In the afternoon of September 15, 1927, we observed that all of the conveys in the tank had temporarily assumed the pale coloration of the specimen shown at the top of plate II. At another time a coney that had maintained the dark red coloration persistently was placed in a separate tank for observation when it assumed and retained the pale phase. The coneys that have been described as *Bodianus fulvus* and its two sub-species *ruber* and *punctatus* are all color phases of one species as may be seen in the accompanying color plate.

* 13th Annual Report, New York Zoological Society.

When similar records of color phases of other species become available, the specific names of a good many fishes will be relegated to the lists of synonymy.

We did not realize at first the extent of the color changes going on in the tanks. When it became apparent that the tropical fishes indulged in many more changes than was supposed, observations were commenced with a view to recording all the changes practised by each species.

Changes in color and patterns are caused by the contraction or expansion of color cells or chromatophores, which contain black, red, yellow or other pigments. The movement of color granules in the color cells is controlled by the nervous system. The stimulus to color change is received through the eye; blind tropical fishes make no response to disturbances or to changes in environment, their color cells remaining inactive.

A fish having little color may greatly alter its appearance by a mere change in the pattern of its markings. The New York Zoological Society authorized the preparation of a series of paintings and photographs of tropical fishes, showing the various changes in color of which each species in the collections of the Aquarium is capable.

The paintings which have been prepared showing from three to eight different phases according to the species, may not even now after long continued observation be complete. Occasionally some fish furnishes a surprise by appearing in a guise not previously noticed. We have indeed found that with most species an additional color phase can be produced by stopping the flow of water until the fish becomes distressed, when it assumes colors or markings different from any of those displayed under normal conditions.

It should not be assumed that the different aspects caught by the artist are all that the species under observation can present. The responsiveness of the color cells to the transient excitements of the fish are such that no



Young male fur seals, Reef Rookery, St. Paul Island, Pribilofs, 1891. A few old males lie near the water.
Photograph by Charles H. Townsend.

two artists portray well known guises absolutely alike. No two photographs are quite the same even if the fish in front of the camera has not moved. While certain general changes in appearance are identifiable by any one, it soon becomes evident that intensity of color or pattern depend upon the individual fish under observation. In the coney, the graysby, the red hind, the hog-fish and most of the groupers, we are confronted with such activity of the chromatophores, that no two of a species are ever completely identical in appearance.

It is evident that the amazingly varied appearances possible to tropical fishes, so readily observable under the conditions of captivity, have not been fully appreciated by those who have studied them at longer range. No other creatures can compare with the fishes in this respect. All impulses, reactions, movements, find instant reflection in the kaleidoscopic color cells.

The visitor at the Aquarium need not expect to see in a short time many of the colorations of which a species is capable. The records and pictures presented here are the result of long-continued observation by the recorder and the artist, both by day and in the dusk of evening. Some of the recorded changes in appearance were brought about only by experiment.



Portion of a fur seal rookery. From a photograph made by Charles H. Townsend in 1897.

RECUPERATION OF THE SEAL HERD

By CHARLES H. TOWNSEND

THE fur seal herd on the Pribilof Islands in Bering Sea now numbers 808,870 animals of all classes, acording to the annual census made by the Bureau of Fisheries in August, 1927.

As a result of long continued seal killing at sea by British, Japanese and United States vessels, the Pribilof herd had been brought to a very low ebb by the year 1911, when there were but 127,000 seals remaining. Sealing by vessels had practically ceased to be profitable and the killing of surplus male seals on the Islands by the United States government had been correspondingly reduced. A treaty providing for the cessation of pelagic sealing for a term of fifteen years was entered into by

the above named powers, including also Russia to whom the Asiatic fur seal herd inhabiting the Commander Islands, belonged. Under the protection thus afforded the tide of seal life rose steadily.

The benefit to the breeding herd resulted from the great saving of female seals which has always constituted the bulk of the pelagic catch. As the stock of seals increased it became possible to take more skins of superfluous males of these highly polygamous animals. For the past ten years the number of skins of males available for the fur market has usually exceeded twenty thousand. The price of dyed seal skins sold by the Bureau of Fisheries in October, 1927, varied from $31.00 to $34.00; those sold in May, 1927, varying from $31.00 to $49.00. The total number of skins of non-breeding males taken at the Pribilofs during the year was 25,006.

Although the international fur seal treaty expired in 1926 and has not been formally renewed, it appears that the powers concerned have tacitly agreed to a continuance of the present status. Japan it is intimated however, has suggested some modification respecting the Asiatic herd which in winter migrates toward the Japanese coasts. This point may later receive consideration.

The present gratifying condition of the American seal herd indicates that the supply of marketable seal skins will increase from year to year with the steady increase of the breeding stock. There is reason to believe that the supply of seal skins from the American herd, will in time increase to the annual catch of 100,000 skins that was available prior to the development of the destructive pelagic sealing industry. The once common sealskin cloak may reappear before many years for the benefit of wearers of furs, and thus afford some respite to the small fur-bearing animals already threatened with extinction all over the world, by reason of the insistent demands of the fur trade.

The outlook for the restoration of the Asiatic herd to its former commercial importance is unfortunately, not promising. During the world war the Commander Islands received little protection from Russia, with the result that the seal rookeries of those islands were often raided by sealing vessels, with disastrous results to the stock of breeding animals.

If complete protection can be secured, there are small groups of breeding seals remaining on the rookeries of both Bering and Copper Islands of the Commander group, that might be sufficient for the eventual restoration of the sealing industry on those islands.

The fur seal herd of the small Robben Island in the Okhotsk Sea, belonging to Japan, is reported (census of 1926) as consisting of 24,373 animals. The number of surplus males taken in that year by the Japanese government was 1,332.

It was our fortune to see the great fur seal rookeries of the Pribilofs just forty-two years ago, before the destructive pelagic sealing industry began. The seals were then roughly estimated at a few "millions." In the late 'nineties when the herd had been decimated we participated in the actual counting of seals remaining on the nearly deserted breeding grounds. With the herd on the increase the annual "census" of breeders that has been made since then, will become more difficult and will eventually become impracticable. As we saw them in 1885 they were considered "countless" in the sense that buffalo on the western plains and antelope in Africa were countless.

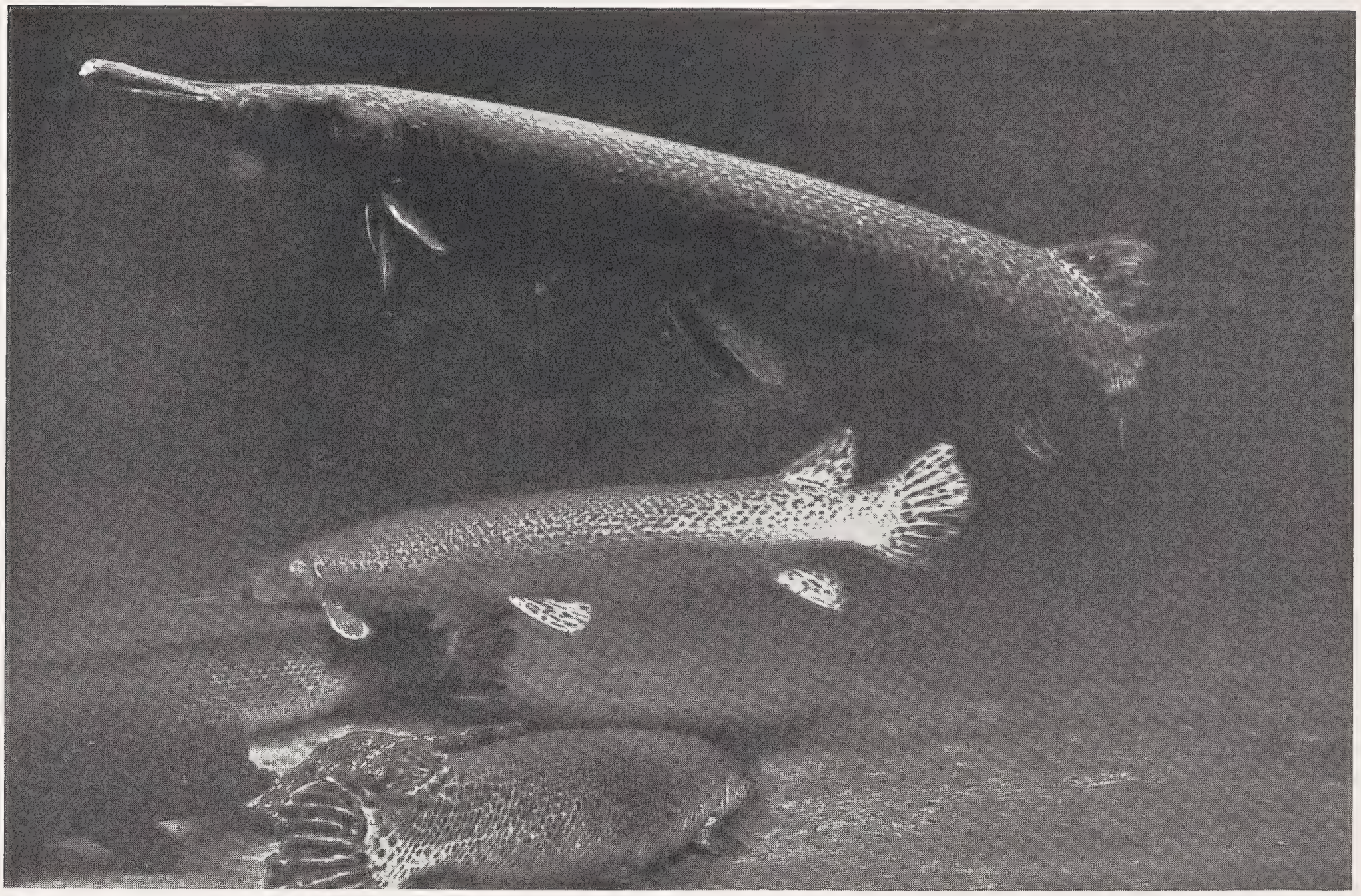
NOTES ON THE ALLIGATOR GAR
(*Lepisosteus tristœchus*)

By CHARLES H. TOWNSEND

DURING a recent houseboat cruise on the Calcasieu River in Louisiana, as the guest of Mr. Henry D. Whiton of New York, the writer learned something of the habits of this large and voracious fish.

According to Mr. A. B. Goos of Lake Charles, Louisiana, who accompanied the houseboat, the gar deposits its eggs in May and June. The spawning fish lies close to a log that is partly submerged, turns on its side and ejects the adhesive eggs so that they adhere to the log. Some of the eggs are at times thrown above the water and lie on the exposed surface of the log where they dry up and are lost. Gars are often visible early in summer when the water becomes warm and lie close to the surface.

Fishermen often take them in seining. In a day's work several gars from two to four



Giant Garfishes (*Lepisosteus tristoechus*) presented to the Aquarium by Henry D. Whiton.
From a photograph by Elwin R. Sanborn.

feet in length are captured and thrown ashore, many of the smaller gars slipping through the meshes of the nets. Gars of large size usually break through the seines and escape. Mr. Goos pointed out the remains of an eight-foot gar that had been taken several months before, the ground being covered with its heavy indestructible scales. The lower jaw of this specimen measured thirteen inches in length and is now in the writer's possession.

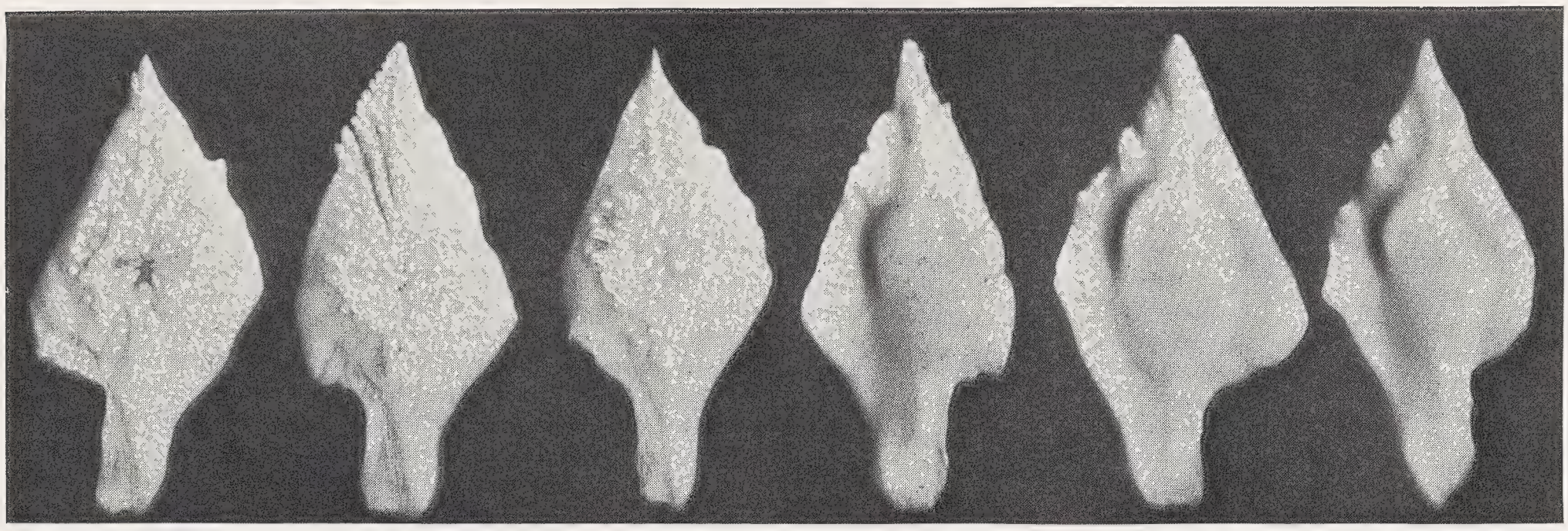
According to local fishermen, alligators sometimes fight with and kill gars. The largest gars we have seen in the museums of New Orleans, Chicago and New York measured not less than eight feet in length. Mr. Whiton furnished a record of a twelve-foot specimen killed on Lake Calcasieu and measured by M'sieu Tata Ibert. He saw the broken remains of the fish and says it was so much larger than any of the eight-foot gars known to him, that he accepts M'sieu Ibert's statement.

The following letter relative to alligator gars in the vicinity of Brownsville, Texas, was received from the late Dr. J. L. Wortman, anatomist and palaeontologist, to whom I had written on the subject.

"I have been making diligent inquiry among my fisherman friends in regard to the habits of the Gar. No one seems to know very much about their spawning habits. It does seem to be a pretty well established fact, however, that in March and April, the females are taken with the eggs or roe still in them. It is the belief of all those, who are in a position to know most about the subject, that the spawning season is somewhere between the first of May and the middle of June.

"On one occasion I saw a female Gar that had been taken from the Rio Grande, of between six and seven feet in length, at the Tepehuaje Ranch, on the Mexican side of the river, filled with roe that were apparently ripe and about ready to be discharged. This was on or about the 10th of May.

"There was one peculiar circumstance in connection with these Gar roe, above mentoned, that was of especial interest to me, and that was when they were taken out and fed to chickens, they proved highly poisonous to



Scales of the alligator gar (*Lepisosteus tristoechus*) photographed natural size. Scales at left (rough) are exterior surface; right, interior surface.

them. On this occasion the man who practiced the 'stunt' lost more than 50 chickens within a few hours. It is a common belief among the Mexicans that the eggs of the Gar are poisonous to all birds, but for the truth of this statement further than it relates to chickens, I cannot vouch.

"The Gars grow to a great size here, and a length of eight to nine feet is not uncommon. The greatest weight I have heard of is 150 pounds. They seem to inhabit salt water, brackish water, or fresh water with equal facility. They are frequently taken by the fishermen in their nets, while fishing for purely marine species, but their most common habitat is the rivers and esteros, where they grow to a large size. When these esteros dry up after a prolonged period of drought, the Gars are the last to perish, and I have frequently seen them living in thick, slimy mud, where one would be led to suppose that no fish could possibly survive. They seemed to have great vitality and are very voracious. It is said to be impossible to raise domestic ducks or geese around these esteros on account of the Gars. They eat up the ducklings and goslings within a few days after they take to the water.

"One would naturally be led to infer from their extreme antiquity that they would show signs of diminution and disappearance. Such, however, does not appear to be the case, since they appear to be abundant and vigorous, and well adapted to their environment. That they live individually to an extreme old age is evidenced by the great size they attain, coupled with the slow growth of the individual. In this respect they appear to be strictly comparable with the Alligators among the Reptilia, in which the size of the individual bears a relation to the age. Those who are prone to multiply species on insufficient characters, such as those of size, as well as changes in skeletal characters due to age, can learn an important lesson by a careful comparison of the anatomical characters of a specimen of Gar eight feet in length and one two feet in length. I dare say that the bones of one of the large individuals if found in a fossil state would easily take a new specific name such as *Lepisosteus gigas, Lepisosteus titan* or possibly *Lepisosteus imperator.* Yet when the truth of the matter is known they are all one and the same species. This is practically all I can tell you for the present of these remnants of the Palæozoic period."

The spawning period of the alligator gar may be longer than is generally supposed. In November, 1919, the writer dissected a six-foot female Gar taken from Calcasieu Lake that was distended with eggs to an amazing degree. When slit open with a heavy butcher knife the large and elongate egg masses fairly bulged up through the opening that had been made.

There is little information in ichthyological works respecting the habits of the alligator Gar.

The scale of the alligator Gar strongly resembles in size and shape, the piece of chipped flint widely used for arrow tips by American aborigines. Being sharp-edged and of flinty hardness, it is possible that it may have been

used for arrow tips in regions where flint was unobtainable. Dr. Clark Wissler of the American Museum of Natural History to whom I sent specimens, makes the following comment on my inquiry regarding their possible use by Indians.*

"I have found the Gar fish scale of special interest and have canvassed the subject with our archaeologists, but no one recalls having found specimens associated with artifacts. It is quite possible that with the scale stained and weathered, it might be passed over as a stone point and so escape detection.

"In any case I greatly appreciate your calling our attention to this and we will certainly be on the lookout for examples."

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*AMERICAN MUSEUM OF NATURAL HISTORY

Dear Doctor Townsend:

You were kind enough to send me some fish scales and to suggest that they might have been used for arrow points and while as I stated to you no archaeological evidence has come to hand that such scales were used, I have accidentally chanced upon a statement in an old book, under date of 1768, entitled The Travels of Peter Williamson, as follows:

"Their manner of pointing arrows is as follows:—cutting a bit of thin brass, copper, bone or scales of a particular fish, into a point with two beards, or some into an acute triangle, they split a little of their arrow, which is generally of reeds; into this they put the point, winding some deer's sinew round the arrow," (p. 77-78).

Very truly yours,

February 20, 1928. (*Signed*) CLARK WISSLER.

NOTES ON AQUARIUM EQUIPMENT, METHODS AND PROBLEMS

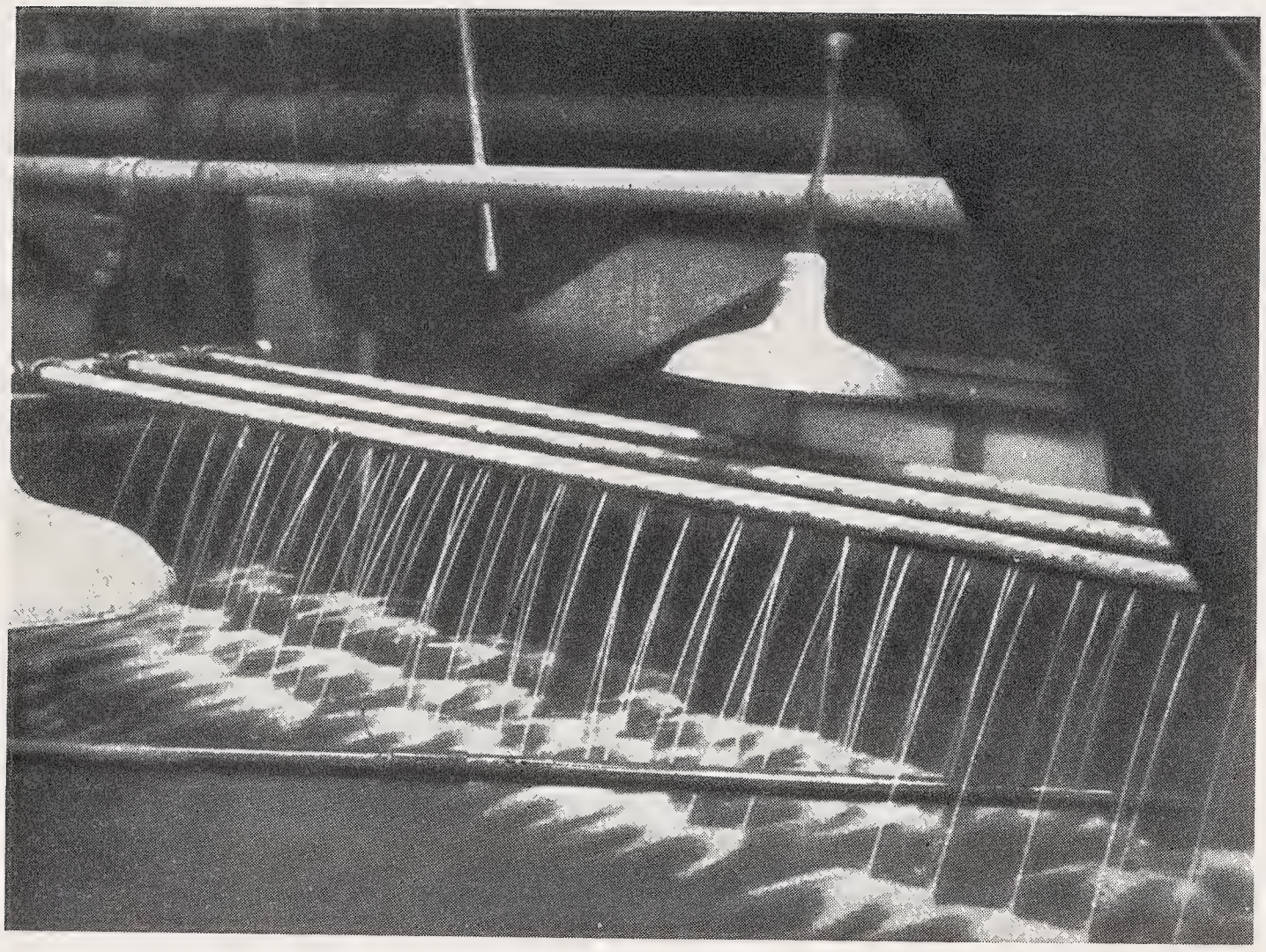
By CHARLES H. TOWNSEND

THE placing of extensive living exhibits in a large aquarium does not by any means imply that they can be kept there by mere routine methods. Constant study of the artificial conditions of life to which they are subjected is necessary. No aquarium can maintain its collections successfully until its water systems have been perfected and all other matters connected with the necessities of living aquatic animals have been provided and faithfully maintained. Frequent re-stocking to make up for losses is merely evading the problems that arise—an aquarium is successful only when its exhibits live and thrive. Keeping up the show by replacements means indifferent management. The matters here discussed will serve to illustrate the necessity of study, experiment and profiting by experience.

Hibernation—Many of our captive fresh water fishes cease to feed when the water becomes cold, some of them lying torpid for months. A moderate warming of the fresh water before it is supplied to the fish tanks induces the occupants to feed occasionally, with the result that they are less weakened by long semi-hibernation. Losses among captive fishes are greater in spring than at other seasons of the year. Wild fishes captured early in the spring are subject to the same fungous troubles that afflict captive fishes after hibernation and the losses among them are greater.

We do not subscribe to the theory that hibernation is beneficial to northern animals merely because it is natural. It is in reality an unavoidable test of endurance by which they are undoubtedly more or less weakened. Nature eliminates these individuals whose vitality is not equal to the rigid conditions which she imposes. The survival of the hardier under natural conditions, would be less certain if the hibernating period were to be unnaturally prolonged. The flying squirrels that sought winter protection in my deserted mountain cabin, failed to survive in the uncovered heaps of clothing where they hid. They would have been warmer in the deep hollows of trees. We have found ground squirrels frozen under similar conditions. Practically nothing is known about winter losses among pond turtles, frogs and salamanders that fail to dig deep enough for safety. Captive box tortoises that winter safely in cellars, survive doubtless because such situations are at least as warm as those they are able to find out of doors. An early springtime must be of saving power to some of the hibernating animals.

There can be little doubt that most of the fresh water fishes and the larger salamanders would winter in better condition in the Aquarium if the water temperatures were maintained at about sixty degrees. Water of normal winter temperature is satisfactory for



New method of aerating water for trout at the New York Aquarium. This method of treating city water in summer has supplanted the practice of cooling by refrigeration.

salmonidae and other fishes that continue to feed when water temperatures are lowest.

Aeration Better than Refrigeration.—The fresh water used in the Aquarium is derived from the City water system. Its monthly mean temperature as it flows into the building during July, August and September is 68 degrees which is above the limit of safety for trouts and other cold water fishes. Before the water from the Catskills was turned on in 1917, the monthly mean temperature for those months was 70 degrees.

The Aquarium has a refrigerating plant to provide cool water for all salmonidae in summer. Until recently it has been kept in operation as long as water temperature was above 60 degrees. The use of a refrigerating plant involves the keeping of cold water fishes in a "closed circulation." None of the salmonidae thrive under such conditions as the quantity of cold water in use is not large and soon acquires a high nitrate which causes losses.

Finding it difficult to get satisfactory results with refrigerated water used as a closed circulation, another method of treating water for cold-water fishes has been worked out at the Aquarium. Three lines of one-inch pipe have been carried horizontally across the top of each large tank containing trout, salmon, whitefish and other species naturally inhabiting cool waters. These pipes are raised a foot above the surface of the water, their under sides being perforated with eighth-inch holes three inches apart. The numerous small streams thus provided, strike the water with force enough to penetrate about three inches, supplying considerable aeration and at the same time being cooled only about one degree in falling through the air. The jets can be so directed as to maintain a current in the tank. The results have been such as to show that this method of aerating and cooling will safely supplant the ordinary method of cooling by refrigeration. Good aeration is apparently of more importance to salmonidae than mere cooling. Trout can live in rapid water exposed to the sun, of higher temperature than that of shaded but sluggish streams. With an electric fan blowing on the numerous jets the temperature can at any time be lowered about four degrees. The fan is seldom used and only when summer water temperatures are highest.

By employing these methods the Aquarium has for three seasons in succession avoided the expense of operating the refrigerating plant and has abandoned its use altogether.

The interesting point is that trout will live in rather warm water of 68 to 70 degrees if it is highly aerated, while they do not thrive in cool water of 60 degrees but lacking high aeration. It would seem that owners of small trout streams that get rather warm in summer, might greatly improve conditions for trout by providing numerous small artificial falls and rapids wherever the flow of the stream might permit.

Combinations of Species.—The common aquarium practice of devoting as far as practicable, a tank to each species is not always best for the fishes so placed. Many kinds are



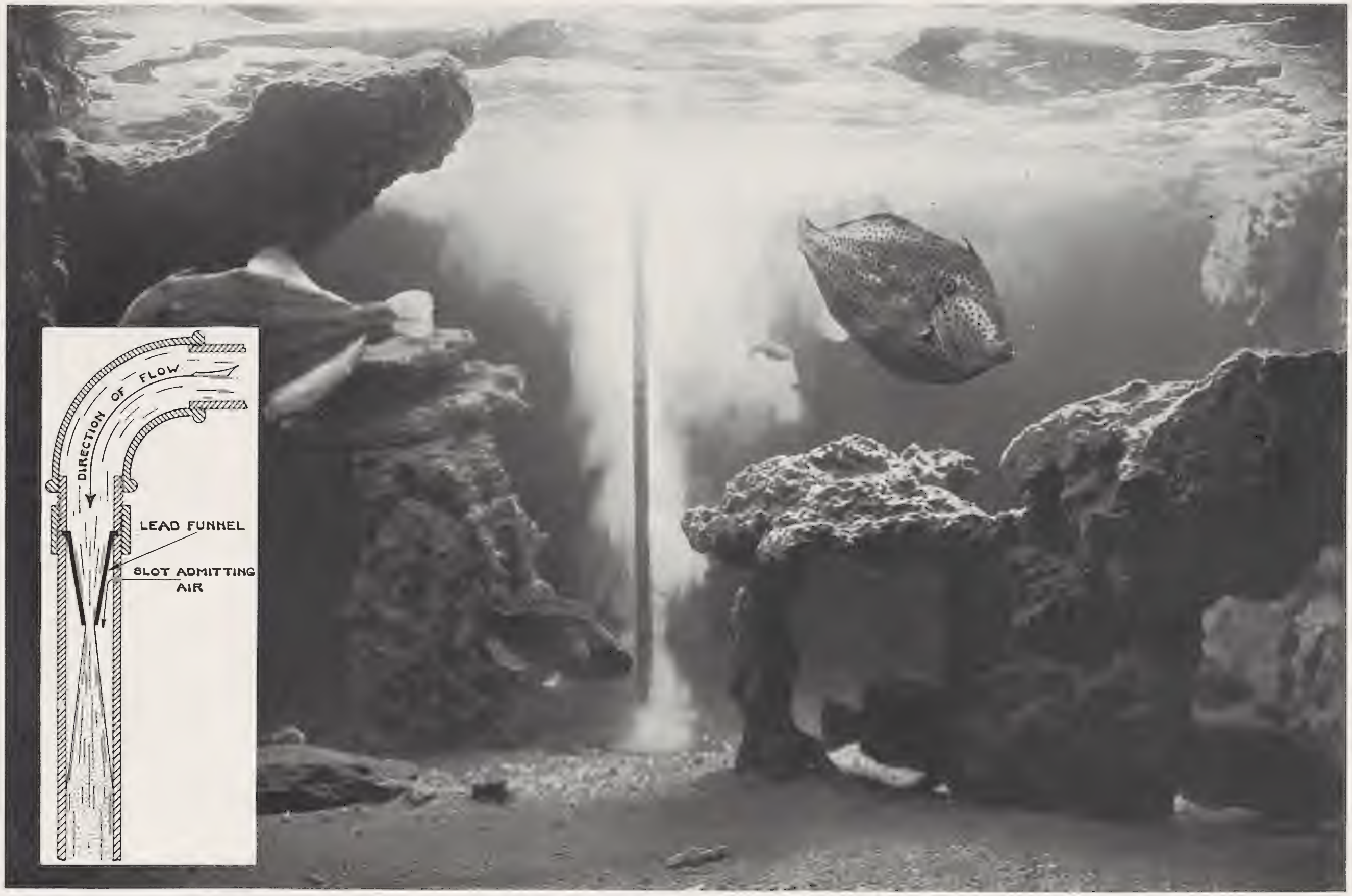
Net used in emptying the "well" of the collecting boat Seahorse. The net is spread at the bottom by a rectangular galvanized frame.

gregarious and when grouped according to their capacity for dwelling amicably with other species of similar size, often do better than when kept separately. The labeling of groups of species thus combined is not so simple, and they are not so easily identified by the visitor, but the exhibit is sure to be a livelier one and the fishes find interest in their more varied surroundings sufficient to appreciably prolong their lives. Under such treatment they are not so easily fed. Active feeders may thrive at the expense of those that feed slowly. Suitable combinations can be learned only by experiment. There are many kinds of familiar little fishes that flock together about the wharves in tropical waters, which can be kept together in the tanks of an aquarium to better advantage than when separated by species.

Aeration of Sea-Water Supply.—Aerating the water as it is distributed to each exhibition tank has been found helpful. It permits some reduction of flow, which is worth while economically if circulating pumps have to be driven at full capacity. It helps in clarification, and if the aeration is properly managed, makes the inflowing current charged with fine air particles, *visible*. A supply pipe fitted for aeration is extended to the bottom of the tank, whence the air-charged water rises like a fountain, adding an element of liveliness to the picture otherwise quiet except for the movement of the living exhibits. It also simplifies the work of inspection during the hourly examination of the tanks at night, the water flow being visible.

Such aeration is accomplished by perforating the supply pipe at a connection a few inches above the surface of the water and inserting a two-inch tube of slightly smaller diameter in the manner shown in the accompanying diagram. Without the smaller tube, the air would rise to the surface in useless large bubbles: with it, the air escapes in a way that gives it the appearance of a fine white mist. We are now extending this new system of water aeration to all tanks in the Aquarium.

Liberated into the bottom of the tank in this way the air carries with it to the surface the finer particles of dirt in suspension which float off through the overflow pipe. In some European aquariums the water is supplied at the surface by a strong jet directed into a pipe leading to the bottom where the water escapes finely aerated. The same effect may be produced by plugging the outlet of an air pipe with porous wood, preferably linden, through which the air from the compressor escapes as a "mist" visible everywhere in the water of the tank. In the aquarium at Washington "filtros" plugs are used in air pipes, being less likely to become swollen and clogged. Aeration in this way is more effective than through the water pipe, but it necessitates the continuous operation of the compressor. In the New York Aquarium the air compressor is seldom used except when pumps are stopped and water flow is cut off temporarily. At such times mechanical aeration is imperative until the flow of water is restored.



Exhibition tank at the New York Aquarium showing the method of aeration of the water. The insert, from a drawing by Charles M. Breder, Jr., illustrates the mechanics of the method. Photograph by Elwin R. Sanborn.

Reservoir for Sea Water.—Sea water as used in American and European aquariums is stored in underground reservoirs adjacent to or underneath the aquarium building. It is used as a "closed circulation" being pumped continuously to the distributing levels, whence it flows in turn to exhibition tanks, filters and finally, back to the reservoir. The filtration process which keeps it clear, eliminates, of course, whatever minute forms of marine life it may have originally contained. It is moreover kept in the dark to prevent the growth of algae. There is some loss through evaporation and leakage which is made up from time to time, by small additions to the original supply. The increase in salinity resulting from evaporation appears to be negligible. After years of service the stored supply suffers little deterioration if properly managed. There is an increase in its acidity, resulting from the wastes from the numerous animals which live in it. Such deterioration as takes place, is to some extent counteracted by the occasional additions of pure sea water of ocean salinity.

The underground reservoir of the New York Aquarium was installed in 1908 after experience had shown that the brackish and sewage-laden water pumped from the harbor was not suitable for the keeping of marine animals. The original supply of stored sea water has been in use ever since.

This reservoir of reinforced concrete and of 100,000 gallons capacity, is divided into four adjoining chambers of equal size, connected with each other by valve-controlled, equalizing pipes. Water returning from the filters is discharged into the first of the series and pumped from the last.

A small central valve chamber is equipped so that water may be pumped from and returned to any combination of the four chambers desired. As any three of the reservoir chambers may be made to hold all of the supply, it is possible to empty them in turn for such cleaning as may be necessary on account of sediment. This has seldom been found necessary, owing apparently to the constant filtration of returned water.

A reservoir should be of sufficient capacity to hold at least twice the quantity contained in the entire series of exhibition tanks which it serves. A large supply gives the body of water in the reservoir more opportunity for precipitating the finer particles of matter in suspension. In winter the necessary temperature can be maintained to better advantage with a large body of water.

An analysis of the long-stored water supply was made in 1927 which showed it little changed, except that "its alkalinity had disappeared and the high nitrate (70.00) had accumulated by oxidation of the nitrogenous refuse of the fishes." The most effective procedure under the circumstances was believed to be the renewal of the entire supply and this was accordingly done late in 1927. Considering the depleted condition of the maintenance fund of the Aquarium at the time, it is a matter of congratulation that this was accomplished without expense. Through the kind offices of Mr. Henry D. Whiton of the Executive Committee, a new supply was brought from the open sea by the steamer *C. A. Snyder* of the Union Sulphur Company. It should be noted that the original supply of stored sea water was in highly successful use for nineteen years.

Placing of Aquarium Glass.—The large tank fronts of polished plate glass are very heavy being one inch or one and one-quarter inches in thickness. The plate is set against a frame of three-inch angle iron built into the masonry or concrete of the tank. In some aquariums the glass is set in a detachable iron frame which is bolted against the iron frame of the tank from the outside. In the New York Aquarium it is set from the inside, without the use of bolts, being held in position chiefly by water pressure when the tank is filled. When put in place the plate is secured by a light strip of wood at each end, which is held by brass screws to woodwork firmly set in the concrete of the tank. The lower edge of the plate rests on a strip of wood laid on the angle iron. Between the glass and the iron frame a flat rubber strip one inch wide by one-eighth inch thick is placed to serve both as a cushion for the glass and an aid in making its border water-tight all around. As a further precaution against leakage, the border of the plate is packed with flexible aquarium cement. Whether set from the inside or bolted on in front, it is absolutely nec-



One of the flour pools at the New York Aquarium containing besides turtles and small alligators, a collection of gulls and a Canada goose that was rescued exhausted from a long flight in a starving condition. Photograph by Morris Rosenfeld.

essary that the glass and its rubber cushion be flat and true against the iron frame. Otherwise cracks will develop under water pressure and the plate be ruined. It is no easy matter even for experienced aquarium men to set the glass so "true" that it will be perfectly supported at every part of its border. Polished plate of the thickness required is expensive, costing at the present time $75 for those measuring four by five feet, and $85 for those measuring four by seven feet. While our share of breakage has through long experience been reduced to the minimum, it is a frequent source of annoyance and expense among the newer aquariums of the country, judging from the many letters of inquiry received respecting the details of glass-setting. Extra thickness of glass does not compensate for uneven pressure against the supporting iron frame. A little crack starting at the edge of the plate will in a few weeks extend clear across it and the troublesome and expensive process will have to be repeated with painstaking care in order that the plate may withstand the strain of constant pressure.

Visitors should not be permitted to tap the glass with canes or umbrellas. It is for this reason that such articles must be checked at the door. When under heavy water pressure cracks in glass are easily started.

Cleaning of Tanks.—All tanks containing living exhibits require cleaning at times. This procedure causes disturbance that is more or less harmful to the occupants. No fixed rule on cleaning can be laid down, owing to the varied conditions which prevail in a series of tanks. Some of the larger fishes are affected but little while many of the smaller kinds become alarmed.

Tanks of small or medium size are usually cleaned by siphoning with a one-inch hose, with only partial lowering of the water. At times it is desirable to use a long-handled brush in cleaning the inner surface of the glass. The rock-work lining of the tank requires occasional brushing, which can also be done without lowering the water. Crevices in the rockwork can be reached only by using a hose with a strong flow after the tank has been drawn as low as safety permits.

The large tanks are half-emptied for cleaning by opening the bottom drains. While the water is flowing out, wastes and sediments are carefully swept toward the drain. Frequent use of the hose siphon serves to reduce the necessity of frequent cleaning with the brush.

Frightened fishes are liable to injure themselves if tank cleaning is left to careless persons. In cleaning fresh water tanks, the waste water goes to the sewer line; in tanks containing stored sea water, to the filter. Fresh water tanks need frequent cleaning at times when *Saprolegnia* is troublesome. This fungus forms quickly on bits of unconsumed food that have not been removed.

Floor pools being occupied by heavy feeders, should be emptied daily and cleaned with long-handled brushes if they are to be kept in sanitary condition.

We have learned that the keeping of numerous crabs, crayfishes and lobsters with such fishes as are not inclined to disturb them is desirable. They are not only of value as exhibits but assist in the removal of unconsumed food unfavorable to the purity of the water.

Injury and Disease.—There are frequently fishes in an aquarium that have become unsightly because of injuries, fungous growths or ailments less susceptible of treatment. Fishes of the pike family may lacerate each other with their sharp teeth but will recover if isolated. Fishes with fins damaged in capture or transportation can regenerate them. Sea fishes are frequently blinded by fighting and being useless for exhibition must be destroyed.

Fungous growths may be checked or even cured by the use of salt, permanganate of potash or peroxide of hydrogen. Diseased specimens should be removed and the tank sterilized with a strong solution of copper sulphate. "Water mould" (*Saprolegnia*) a fungus, is sometimes kept in check by adding a small stream of sea water to the flowing fresh water. It is sometimes desirable to use permanganate of potash, 1 part to 1,000 of water, flooding the tank with this light solution for several hours. Water mould is sometimes removed by brushing the spots with kerosene. Sea fishes are fortunately free from fungous troubles.

Costia, a protozoan parasite, is usually controllable by placing a large piece of rock salt



Spadefish (*Chaetodipterus faber*) from Key West, Florida.

in the tank, against which the fishes are inclined to rub themselves. Strong solutions of lime water in the tanks have been found useful in the treatment of *Ichthyophthirius*.

Goldfishes suffering through failure of the slime organs to function, have been restored by dipping in kerosene for a minute.

Angel fishes becoming blinded by minute flukes have been treated successfully with silvol. Gars covered with crustacean parasites (*Argulus*) have been cleared of the pests by dipping in a solution of mercurochrome. Some parasitic attacks have been successfully combatted by vinegar baths.

It is not the intention to enter here into details on the treatment of ailing fishes in the large tanks of the public aquarium. With the common and easily obtainable fishes the usual practice in this country is to destroy those that are unsightly and replace them with fresh specimens. This procedure may be convenient but it is an evasion of the problem and a confession of defeat. The flow of water, its temperature, filtration and aeration, and the methods of feeding and tank cleaning may need attention. Overcrowding is a frequent cause of trouble. The isolation of newly arrived fishes until their condition can be ascertained is desirable. The fishes may be benefitted by sand in which they often rub themselves. Caretakers may be unequal to the diagnosis and treatment of disease but with the help of a biologist the difficulties may often be overcome. The numerous books written by fish fanciers on the care of fishes kept in small aquaria usually contain suggestions on treatment that are worth trying out but the handling of large numbers of fishes in a public aquarium is more difficult.

Aquarium managers are exchanging opinions on the results of their experiments and there is evidence that progress is being made.

Emptying "Well" of Aquarium Boat.—Removing fishes from the well of the collecting boat with dip nets is rather difficult and causes needless disturbance. This operation is now avoided by sinking into the central part of the well a stout fine-meshed net lining before any specimens are introduced. The net is sunk and spread at the bottom by a large rectangle of light galvanized iron. Its top is hung on hooks around the sides and ends of the well. The catch as a whole is removed by simply hoisting the net until all specimens are within easy reach, when they are transferred to the tanks of the Aquarium with the minimum of disturbance. The roomy well space on each side of the removable net is available for skates, sharks or other extra large specimens.

Longevity of Fishes in Captivity.—A fair proportion of the species of fishes exhibited in public aquariums survives under the restrictions of captivity for many years. A larger proportion being less hardy, is more difficult to provide for, while some kinds needing foods not readily procurable, or altogether unobtainable in winter, do not live longer than a few months. Tropical fishes kept in northern aquariums cannot be supplied with the variety of foods obtainable among their native reefs. The restricted amount of live food available has probably as much to do with losses as any factor in aquarium management.

In the New York Aquarium, which is well supplied in summer with small marine invertebrates, losses are reduced to the minimum during more than half of the year. With most aquariums the food supply, especially in winter, is dependent upon what can be found in the markets. Nevertheless, many of them have records for certain kinds of fishes, that indicate a high average of success in keeping them.

The New York Aquarium has kept specimens of gar (*Lepisosteus*), mudfish (*Amia*) and striped bass (*Roccus*) for twenty-four years. Many of these are still living. Among fishes which have lived twelve years or longer are sunfish (*Lepomis*) three species, rock bass (*Ambloplites*), calico bass (*Pomoxis*) and perch (*Perca*). There is a 200 pound jewfish (*Promicrops*) which has been living in one of the tanks for eight years. There is a similar record for the nurse shark (*Ginglymostoma*) although it has not yet reached a length of three feet.

Many species of groupers (*Mycteroperca*), hinds (*Epinephelus*) and grunt (*Haemulon*) are living in the tanks after more than eight years of captivity. The list of long-lived fishes could be greatly extended. A sea lion (*Zalophus*) lived 19 years in one of the large pools and a giant salamander (*Cryptobranchus*) is still living after thirteen years.



Porkfish (*Anisotremus virginicus*) in a reef-like setting.



One of the most satisfactory exhibits in the entire Aquarium—a variety of Groupers and Hinds.



Giant Grouper (*Promicrops itaiara*). Small air bubbles have settled on the head of this fish. Many of the larger fishes deliberately "bathe" themselves in the air sprays with apparent enjoyment.



Another view of the exhibit shown on page 21. These fishes habitually recline in rock cavities.



Dog Sharks (*Mustelus canis*) and a Green Turtle (*Chelonia mydas*).



A yawning Grouper in the shelter of an artificial reef cavern.



CHARLES HASKINS TOWNSEND

Director of the New York Aquarium since 1902.

OLD TIMES WITH THE BIRDS: AUTOBIOGRAPHY[1]

By CHARLES H. TOWNSEND

I insert in this BULLETIN *the following article from an ornithological journal,[1] for the reason that it will acquaint the Zoological Society with the earlier activities of the man who has been Director of the Aquarium for the past twenty-five years. It begins with the days when flights of wild pigeons darkened the sky, a phenomenon of vanished bird life that only our older members will recall. It says too little about the numerous new species made known to science by the writer. It recalls personal relations with eminent ornithologists who have passed away. It concludes with accounts of remarkable aggregations of northern birds that few persons have seen.—M. G.*

MY first book of birds, a happy discovery in our household library, was contained between the covers of a bulky report of the United States Department of Agriculture for the year 1856. It was a fifty-page chapter on *Birds Injurious to Agriculture* by Ezekiel Holmes, illustrated with thirty-two full-page woodcuts after Audubon. It supplied what I needed fairly well, the only other work in the house on natural history being J. G. Wood's *Bible Animals,* which unfortunately did not apply to my part of the world. When the old home was abandoned years later, I rescued this treasure of youth and had it bound, together with another chapter from the same ancient and battered report, almost as much prized, on the *Quadrupeds of Illinois* by Robert Kennicott, the naturalist, whose trail in northern Alaska I crossed years after.

Ornithologists would not now admit that some of the birds discussed by Ezekiel Holmes, such as kingbird, orchard oriole and rose-breasted grosbeak, are injurious to agriculture. They are, in fact, rather reluctant about admitting that any bird is very injurious. The Carolina "parakeet" was still common in Holmes' day and "exceedingly annoying to the farmers." I still have in my collection a fine skin of this now probably extinct bird, taken near Fort Myers in Florida in the early 'nineties. Inexpensive books on American natural history were not as available in the 'seventies as they became twenty years later. There was no public library within reach and no one noticed my needs.

Our books being largely theological, I naturally turned to Holmes, as my only authority, for enlightenment on the passenger pigeons, at the flights of which I greatly marvelled. The last large flight of these birds in our neighborhood, twenty-five miles east of Pittsburgh, occurred in the spring of 1875. There can be little doubt about the date, as I visited the Centennial Exposition not long after, where I saw mounted pigeons for the first time. The two events are closely connected in my memory. With a single-barrelled muzzle loader borrowed from a neighbor, I killed pigeons in the scattered oaks that crowned a hill half a mile from our country home. The older boys of the neighborhood got more than I did. Some of them with a raking shot along a dead limb got four or five at a single discharge. Their guns were also muzzle-loaders. The birds had been coming pretty steadily since morning, an occasional low-flying flock of two or three hundred lighting on the oaks, while the greater bands of pigeons flew considerably higher and made no stops so far as we could see. They may have alighted on the wooded tops of higher hills a couple of miles farther north.

Looking southward along the western slope of the Alleghanies where the view was unobstructed, we could see the birds coming in many long irregular "streaks"—not compact flocks—the most of which passed during the forenoon. The streaks or bands, mostly advancing end on, were broad and dense in some parts, narrow and almost broken in others, while the far ends in some of them were too distant to be made out clearly. The pigeons may have been coming across the mountains six or seven miles away, which here have a northeast and southwest trend; but this could not be determined. We had heard of a great pigeon roost in Cambria, one of the mountain counties to the eastward. I described these

[1] Reprinted from The *Condor*, September, 1927.

flight formations to Fuertes,[2] who sketched them rather successfully in his picture of the passenger pigeons in Chapman's *Birds of Eastern North America,* but the perspective is not altogether satisfactory. I did not then know how to skin birds. The pair of mounted passenger pigeons now in my possession, the gift of the late Frederic S. Whitman of Brooklyn, came from a roost at Grand Haven in Michigan in 1880.

At that time, so far as natural history was concerned, I travelled quite alone. Some lines written by the Selborne naturalist a hundred years earlier, applied well enough to my locality: "It has been my misfortune never to have had any neighbors whose studies have led them toward the pursuit of natural knowledge; so that, for want of a companion to quicken my industry and sharpen my attention, I have made but slender progress." Delightful and unconscious modesty! The literary world appraised his accomplishment quite otherwise.

They intended me for the clergy, to keep up family tradition; but I was too fully occupied with the natural world to consider the supernatural. A dentist in the neighborhood taught me what little he knew about mounting birds and I formed a small collection consisting chiefly of game birds. The specimens must have been presentable for they were purchased to adorn the rooms of a sportsman in an adjoining county and I was engaged to make additions. This important undertaking languished, as I was forced to attend country school and devote myself to arithmetic, grammar and other uninteresting matters. It was perhaps just as well, as my nucleus of a collection eventually went down the Conemaugh along with the most of Johnstown.

Professor Henry A. Ward introduced me to the museum atmosphere in 1879, when he invited me to Rochester. There I got acquainted with F. A. Lucas and W. T. Hornaday, then in his employ. The three of us later found our several ways to the National Museum and eventually turned up in New York, each as the director of a museum in that city. We are still sitting on the lids of those institutions. Although on a commercial basis the collections at Ward's natural science establishment were varied and accessible, and there was a fair working library, in which I read industriously. Training in museum methods is one of the ways in which embryo naturalists get started on their careers. Some of the young men employed as preparateurs in osteology, taxidermy and other museum work, became college professors, explorers and museum curators. The late Professor W. B. Barrows who wrote much on the birds of Argentina and Michigan, was among the "alumni" of Ward's, as were also George K. Cherrie, Carl Akeley, Prof. Henry E. Crampton, of Columbia, Prof. W. M. Wheeler, of Harvard, and Prof. Ward's son Henry. At that time we were preparing collections for the Museum of Comparative Zoology on a large order from Alexander Agassiz, with whom I sailed later in the *Albatross.*

In 1882 they took me into the Philadelphia Academy of Natural Sciences on my own recognizance, plus a letter of recommendation from Professor Ward, where I dabbled in ornithology and other zoologies, with great personal satisfaction, but to little scientific effect. It took me a long time to find myself, enjoying as I did, everything in nature from birds to pollywogs. The all-around naturalist misses in considerable degree the distinction that attaches to the work of the specialist.

While at the Academy I had some acquaintance with Edwin Sheppard, the artist, and the venerable Titian Peale. Sheppard, a tall distinguished looking man, was drawing birds on little blocks of wood for Coues' *Key to North American Birds* to be engraved by Nichols. I there saw many familiar bird cuts in the making. I recall his telling me one day that he was among those who surrendered to General Grant at Appomattox. His woodcuts do not appeal to bird men in these days of abundant photographs and colored plates, but they have a charm of their own. They are instantly recognizable portraits of the species they represent. There is a delicate expression of light and shade, and the birds are properly balanced on their legs despite the fact that they were drawn from old museum specimens often indifferently mounted. Sheppard like many another bird artist had the habit of sketching in a background in which most of the distant landscape appears *below*

[2] The late L. A. Fuertes, bird artist.

the bird standing on the ground. It must be somewhat of an accomplishment to get a glimpse of the horizon between the legs of a wading bird. But I am not an artist. Gurdon Trumbull used nearly a hundred of Sheppard's birds as electrotypes in his *Names and Portraits of Birds*, and I was mightily pleased when W. L. McAtee reproduced fifty of these in a recent document of the Biological Survey. The camera has given us a new ornithology since Sheppard's day.

Mr. Peale kindly allowed me the use of his Audubon, a volume at a time, my first acquaintance with his work. Later, in the *Albatross* I sailed in Peale's wake in Polynesia, where he had collected and painted birds while with the Wilkes Expedition sixty years before. During that voyage we picked up four hundred birds of ninety-three species, on thirty-three different islands, many of them new. They were reported upon by Alexander Wetmore[3] and myself, Wetmore with his greater ornithological ability doing most of the work.[4] Peale's collection in the National Museum furnished most of the material for comparison. Some of the islands were then visited for the first time by naturalists.

At Whitsunday, an uninhabited atoll of the Low Archipelago, I shot a sandpiper of a species (*Aechmorhynchus parvirostris*) first taken and described by Peale, no other specimens being known. Conditions were unfavorable and my boat was the only one that succeeded in making a landing at this remote but famous atoll. The only other bird I secured there was a new warbler (*Conopoderas rava*). Darwin saw this atoll from the deck of the *Beagle* but could not land. His picture of it is copied from Beechey's *Voyage*. My own, published by Agassiz, was taken from the top-sail yard of the *Albatross*. This was an oceanographic voyage in charge of Agassiz, and our stops were brief except at islands where supplies were renewed. The collecting of birds was largely dependent upon my personal efforts. The skinning had to be done at night after the ship's laboratory had been cleared of the day's deep-sea dredgings.

At Philadelphia, Spencer Trotter, W. E. Saunders and W. L. Baily were the only young men among my associates who made use of the Academy's large collection of birds. Baily one day brought in a hybrid sparrow (*Junco-Zonotrichia*) of which I prepared a description and E. T. Seton a colored plate for the *Auk*. Hybrids between distinct genera of sparrows are rarities and are interesting as throwing light on certain obscure species known only from single examples.

When I met Professor Baird,[5] in 1883, he at once inquired as to my relationship with J. K. Townsend, the ornithologist. All I could say was that we probably had the same Philadelphia Quaker ancestor, mine having arrived there with William Penn in the ship *Welcome* in 1682. Prof. Baird gave me a job in the Fish Commission and within a week sent me to the salmon hatchery on McCloud River, California. Knowing that I was something of a collector, he wrote personal letters from time to time requesting that certain birds be secured. I collected about two hundred species there and around Mount Shasta before it was time to start back to Washington.[6] Professor Baird thought there was a chance of finding white-tailed ptarmigan on Shasta and I followed the timber-line clear around the mountain; and then I tried Lassen Peak awhile before giving up the search. Lassen became an active volcano thirty years later and deeply covered my old collecting ground with ashes. I joined a party of the U. S. Geological Survey for a few weeks that summer (1883) and participated, zoologically, in the survey of Mount Shasta.

Fish cultural duty in California was followed by a cruise with the *Albatross* among the Bahamas in 1886. Our capture of specimens of the long-missing Kirtland warbler and several new species in the Bahamas was a matter of great interest to Prof. Baird. Sir Henry Blake, the governor, came on board often while we were at Nassau, when I taught him to skin birds. This attractive and capable Englishman was afterwards governor of the British colonies of Jamaica, Newfound-

[3] Now Assistant Secretary of the Smithsonian Institution.

[4] Albatross Voyage. Tropical Pacific, 1899-1900. The Birds, by Charles Haskins Townsend and Alexander Wetmore. Bull. Mus. Comp. Zool., Harvard Coll., vol. LXIII, no. 4, 1919, pp. 151-225.

[5] Head of the Smithsonian Institution and U. S. Commissioner of Fisheries.

[6] Field-notes on the Mammals, Birds and Reptiles of Northern California, by Charles H. Townsend. Proc. U. S. Nat. Mus., X, 1887, pp. 159-241, pl. 5 (map), several text-figs.

land, Queensland, Hongkong and Ceylon. He facilitated my bird work in the Bahamas, and one of my new birds from Abaco was named *Centurus blakei*. According to our experience, England always had fine officials in her colonies.

In 1885, I accompanied the U. S. S. *Corwin* on a voyage to Kotzebue Sound and went with Lieutenant John Cassin Cantwell, a nephew of Cassin the ornithologist, on a two months' trip up the Kowak River. We were the first white men to reach its headwaters. It was a hard drive every day, and we often stood waist deep in the icy water getting our launch off the sand bars; but I managed to pick up fifty-two species of birds while above the Arctic Circle. The boreal species were to be expected, but to find such common home birds as robin, swallow, shrike, water-thrush, rusty blackbird, kingfisher and others, was to realize for the first time that birds do considerable moving about. During the trip Cantwell told me more or less about Cassin, but I have no notes on the subject. At the Pribilofs I got the Asiatic stint (*Tringa damacensis*) which was as far off its beat as the stray catbird I found at the Farallon Islands in 1894. Both records remain unique.

After that came a trip to Honduras in 1887 which yielded hundreds of birds and a dozen new species. Professor Baird gave me a letter to Mr. George N. Lawrence with whom I spent an evening before sailing from New York. A student of tropical birds, he talked about the birds I would likely find in Honduras.

This trip included visits to Grand Cayman and Swan islands in the Caribbean Sea. I am unable to recall anything in outpouring bird-song comparable with the early morning chorus of the mockingbirds (*Mimus orpheus*) at Grand Cayman. The continuous volume of melody came from every part of the surrounding shore of the little bay where our schooner lay, as though each of the host of musicians was producing his entire repertory. It was the waking call for all on board. The only approach to it in my experience was the singing of the large babbling thrushes (*Conopoderas percernis*) of Nukuhiva, in the Marquesas. The woods rang with their melody and it was not uncommon to hear several of them singing on a single tree. They were by far the best choristers of Polynesia. Herman Melville, in *Typee,* that classic of Polynesia, said the Nukuhiva birds were all songless. Being the captive of cannibals, he probably had more important matters on his mind than birds. Anyway he was wrong.

Swan Island was visited by a naturalist for the first time when I landed there. I collected thirty species of birds, certainly all that were present at that time.[7] Visiting Swan Island twenty-two years later, Percy R. Lowe[8], now of the British Museum. found some changes in the bird life. The black ani (*Crotophaga ani*) had established itself there, possibly from Grand Cayman, 185 miles distant; but he searched in vain for the red-legged thrush (*Mimocichla rubripes*) which was well represented in my collection.

To enter Honduras at the mouth of the Segovia River was to enter the tropical jungle for the first time and have acquaintance with toucans, trogons, scarlet macaws, brilliant tanagers and others of the feathered host of gorgeous attire. The first camp a few miles up the long river which separates Honduras from Nicaragua, was beside a tree in the open colonized by cheerful hang-nests (*Ostinops montezumae*). A score of yard-long nests swung from the higher branches, suggesting at a distance strange fruits rather than the treetop cradles of young birds. My Indian canoe-men salvaged the bodies of the birds I skinned and put them in the pot along with that of a spider monkey. I did not always participate in their feasts; but sometimes there were delectable pigeons and river turtles, with occasional deer. Farther up and weeks later we entered an open pine forest where scarlet macaws gathered in the high trees like grackles at home. Following the river, the only thoroughfare far inland, with nature's bird and other riches abounding, the half-enchanted naturalist thinks little about

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[7] Catalogue of a Collection of Birds made by Mr. Chas. H. Townsend on Islands in the Caribbean Sea and in Honduras. By Robert Ridgway. Proc. U. S. Nat. Mus., X, 1887, pp. 572-597.

[8] A Naturalist on Desert Islands. By Percy R. Lowe. Witherby & Co., London, 1911, 300 pp., 32 ills.

[9] A Naturalist in the Straits of Magellan. Charles Haskins Townsend. Popular Science Monthly, July, 1910, pp. 5-18, 9 ills.

turning back, and the enchantment lasts until he has drifted out again.

Professor Baird had arranged for the *Albatross* to go to the Pacific in the autumn of 1887 but did not live to see the vessel start. We got birds at many points around South America, especially in the Straits of Magellan[9] and at the Galapagos Islands. The latter collection supplied the material for Ridgway's *Birds of the Galapagos,* supplemented by another collection when I re-visited the islands on the *Albatross* voyage of 1891.

In the Straits sea birds were constant objects of interest. The nesting place of cormorants were marked by masses of black-backed, white-breasted birds, acres in extent. From low island levels Cassin terns rose in clouds of protesting thousands when our boats grounded.

Steamer ducks kept well ahead of the active oarsmen, their flightless wings aiding their webbed feet in a manner suggestive of paddle wheels used as auxiliaries to screw propellers, trailing a foamy wake a hundred yards behind. The species belongs exclusively to southern South America and is altogether the most notable bird of the Straits region. It is said to weigh over fifteen pounds. While it can not, or at least does not, fly, and is seldom inclined to dive, the rapidity of its progress over the surface long ago attracted the attention of explorers and navigators. Most observers are of the opinion that the wings move alternately when in motion. An occasional penguin—that flight-less, burly diver peculiar to Antarctic seas—only showed himself above water in porpoise-like leaps and was seldom easy to get.

The diving petrel, also Antarctic in range, was by special request a mark for all guns, but no specimens were taken. As a quick diver it is a little brother to the northern auklet, which it resembles in appearance and to some extent in habits. When at large there is nothing in its actions to suggest the petrel. It strikes down into the water from full flight, emerging farther on, fairly bursting forth into the air with wings in rapid motion.

The barred Magellan geese are important on account of their abundance. This bird is a resident of the region throughout the year. It is an inhabitant of the open plains and mountain slopes and is a land rather than a water species. It occupies the open country of Tierra del Fuego in enormous numbers and has contributed more to the food of the white settlers now establishing sheep ranches in that country and in Patagonia than any other wild creature. The most familiar bird of the Straits is a species of creeper which follows the hunter constantly through the forest. The Cape Horn wren is as saucy as a wren can be, and the marsh wren creeping through the grass like a mouse, is almost familiar enough to be caught with a butterfly net. Of the hundred or more species of birds to be found along the Straits we obtained about seventy, three of which belonging to the family of "wood-hewers" were new to science. Our bird collection numbered one hundred and seventy specimens in all.

We are indebted to Darwin for the first accounts of the peculiar land birds of the Galapagos, "the importance of which in their bearing upon the study of natural science has never been equalled" (Salvin). Habel collected there in 1868, and two smaller collections were made later by others.

After running a line of deepsea soundings from Panama, the *Albatross* turned us loose on these classic islands for eleven arduous but wonderful days. There was help in the collecting, but I worked until midnight at the preparation of bird skins, leaving to others the preservation of reptiles and such miscellaneous zoological plunder as each returning boat dumped into our upper and 'tween-decks laboratories. Everybody was drafted including the surgeon, who helped to press plants, while boat crews swept the beaches with seins. There were eighteen tortoises crawling about the deck when we sailed, one of them big enough for the sailors to ride. The giant land tortoises for which the archipelago was named, had already disappeared from some of the islands and were scarce on the others. Ships had been carrying them away in large numbers for three centuries. I once made a study of whale-ship log-books to ascertain what the whalers of the nineteenth century did to the tortoises and found that seventy-

nine ships carried away thirteen thousand tortoises.[10]

Half of the land birds are finches. In the peculiar Geospiza finches of the Galapagos, of which Ridgway[11] recognizes as many as twenty-two species, all the males are black. In a few species the bill is thicker and heavier than in any other members of the Fringillidae, while in most of them it varies amazingly in size and form.

We did not collect many water birds, believing that our limited time should be spent on the indigenous land birds. In this way we missed a prize—the short-winged and absolutely flightless cormorant which remained unknown until 1898. Another water bird of unusual interest because of its geographical position on the Equator, but which we did not overlook, is the Galapagos penguin. I have living specimens in the Aquarium that are as lively and engaging as any birds could be. I often lift them out of their pool, to follow me about the floor.

Investigations in the North Pacific kept the ship busy for several years. We surveyed the fishing grounds along the northwest coast and in Bering Sea; sounded the route for the Hawaiian cable; mapped the seal rookeries of the Pribilof and Commander islands; participated in the Bering Sea patrol and charted part of the Aleutian region. I sent many birds to Washington after these voyages, all secured at random as opportunity afforded. This was entirely unauthorized work by a young man supposed to be fully occupied with fishery and other investigations. During this northern work we had our prolonged controversy with England over "The Bering Sea Question." "Pelagic sealing" and "seal rookeries" became household words. The *Albatross* staff had to study fur seals ashore and afloat and supplied much of the matter that filled volumes of pubic documents on both sides of the Atlantic. I never stopped the voluntary picking up of birds when the *Albatross* visited out-of-the-way places. While the detailed instructions sent to the ship before each voyage might cover a wide field of fishery and oceanographic investigations, ornithology was not included. Mr. Ridgway, however, never failed to send me a list of desiderata, and when I had a run ashore in the Fijis, or anywhere else, it was invariably with a gun and a fishing creel for birds. According to engine-room records, the *Albatross* steamed over 200,000 miles while I was with her and the birds sent to Washington numbered among the thousands. When the ship was sounding or dredging in deep water I often lowered a boat and shot petrels, but we never got the long-missing Hornby petrel, of which Mr. Ridgway sent me a colored sketch that hung in the ship's laboratory for years. Later on, Chapman[12] found the Hornby petrel common on the coast of Ecuador. The second and third specimens of the least petrel which had been missing for a quarter of a century obligingly flew aboard the ship, one in Panama Bay, the other off Acapulco. An electrically lighted ship is a good target for night-flying petrels. I have captured twenty in a single night. We got many petrels also when the ship was under way by trailing a long cod line astern, from which were suspended numerous threads with small fish hooks attached. The petrels swinging from side to side in the ship's wake often got their wings hooked, then the cod line would be hauled in.

The new species of birds were generally described by somebody before I got a chance to visit headquarters; but I succeeded in attaching my name to a dozen or more by sidetracking some bird collections at San Francisco and taking them to Washington later on as personal baggage. It isn't safe to leave undescribed species where ornithological nomenclators are prowling about. Mr. Elliot[13], for instance, found some novelties in my collection of Aleutian ptarmigan; but I had at least the fun of shooting them on the mossy mountains of Attu, Aggatu, Kyska and Adak, to say nothing of Atka and Unalaska. And what joy for my setter, who was a sailor for years!

At Cocos Island, Professor Agassiz, then

[10] The Galapagos Tortoises in Relation to the Whaling Industry. Charles Haskins Townsend. Zoologica, N. Y. Zool. Soc., IV, 1925, pp. 55-135, 11 pls., map.

[11] Curator of Birds, U. S. National Museum.

[12] F. M. Chapman, Curator of Birds, Am. Museum of Natural History.

[13] D. G. Elliott, Ornithologist.

in charge of the *Albatross*, gave me a whole day ashore, which was productive of bird rarities.[14] Cocos Island, visited many times by seekers for buccaneers' treasure, had been visited only once before by naturalists when H. M. S. *Sulphur* called there in 1840 and found a peculiar cuckoo (*Coccyzus ferrugineus*). I secured two more specimens of this rarity, a new genus and species of flycatcher (*Nesotriccus ridgwayi*) and specimens of *Pinaroloxias inornata*, a small finch-like bird, previously known from a single specimen and wrongly attributed to the Low Archipelago. The rocks along shore at Cocos are covered with the names of whaleships that went there for water during the early part of the nineteenth century. Cocos is small, high, well wooded and has some small streams. If I had to be marooned on a small uninhabited island I think I'd select Cocos.

Malpelo lies to the southeast of Cocos on the Panama-Galapagos course. I lowered a boat and tried in vain to find a foothold at the northern end. This apparently inaccessible rock is a mile long and nearly a thousand feet high, its top a guano-whitened bird rookery. I did not try the other end where the sea was making a turmoil. I shot four fork-tailed gulls (*Creagrus furcatus*) from the boat and saw others on the cliffs. This was a new locality for *Creagrus*. Only three specimens of this bird were known prior to the voyage of the *Albatross* to the Galapagos in 1888, when I shot two at Dalrymple Rock off Chatham Island.

The *Albatross* once dropped anchor at the Revilla Gigedo Islands, 100 miles southwest of Lower California. While the seining crews were sweeping the beaches for fishes I had a profitable day ashore with the birds. The results were five new species, a burrowing owl, a dove, a wren, and two petrels. Twenty of the petrels came on board at night, six of which were skinned. This was the first visit of a naturalist to Clarion and San Benedicte, the other island, Socorro, having been visited by Grayson, the ornithologist, twenty years before when several new land birds were found. The islands off southern California similarly rewarded my bird collecting efforts.[15]

After a time it fell to my lot to direct the work of the ship. During investigations in the Lower California region, when there were in the ship's company efficient helpers in the labor of bird skinning, we got 800 birds of 159 species from the Peninsula and from islands in the Gulf.[16] A dozen species came from Tiburon Island, the first and, so far, the only birds known from that large unexplored island.

I think I never saw a single species of sea bird in greater numbers within a limited area, than when the *Albatross* entered Yukon Harbor in the Shumagin Islands; everyone on board noticed the increasing numbers of crested auklets as we passed in.[17] The surface of the water was covered and the air filled with them. This lonely and uninhabited anchorage was apparently occupied by crested auklets to the practical exclusion of other birds. Large flocks launched themselves into the air from the lofty cliffs and careened toward the vessel with great speed and loud whirring of wings. During the long evenings the birds were amazingly active. We tried the effect of a long blast of the whistle. The result was startling: bird legions shot out from the cliffs to join the amazing numbers already in the air and on the water. It was a surprising and memorable ornithological display, even to those of us who had seen the almost unbelievable numbers of murres that revolve, like the rings of Saturn, about St. George Island at the Pribilofs.

Other memorable aggregations of birds were provided by the sooty shearwaters that sometimes gather at sea in vast numbers both north and south of the Aleutian islands. We saw at least one of these great congregations every summer, but one seen southwest of the Shumagin Islands surpassed all our previous experiences with them. To discuss their numbers in commonplace terms of millions would not convey the impression made upon us at

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[14] Birds from Cocos and Malpelo Islands, with Notes on Petrels Obtained at Sea. By C. H. Townsend. Bull. Mus. Comp. Zool., XXVII, No. 3, 1895, pp. 121-126, 2 pls.

[15] Birds from the Coasts of Western North America and Adjacent Islands, Collected in 1888-'89, with Descriptions of New Species. By Chas. H. Townsend. Proc. U. S. Nat. Mus., XIII, 1890, pp. 131-142.

[16] Albatross Voyage. Gulf of California. Birds Collected in Lower California. By Charles Haskins Townsend. Bull. Amer. Mus. Nat. Hist., XLVIII, 1923, pp. 1-26, 1 pl., map.

[17] The Crested Auklet, by Chas. Haskins Townsend. Educational Leaflet, no. 65, Nat. Assoc. Audubon Soc., 1913.

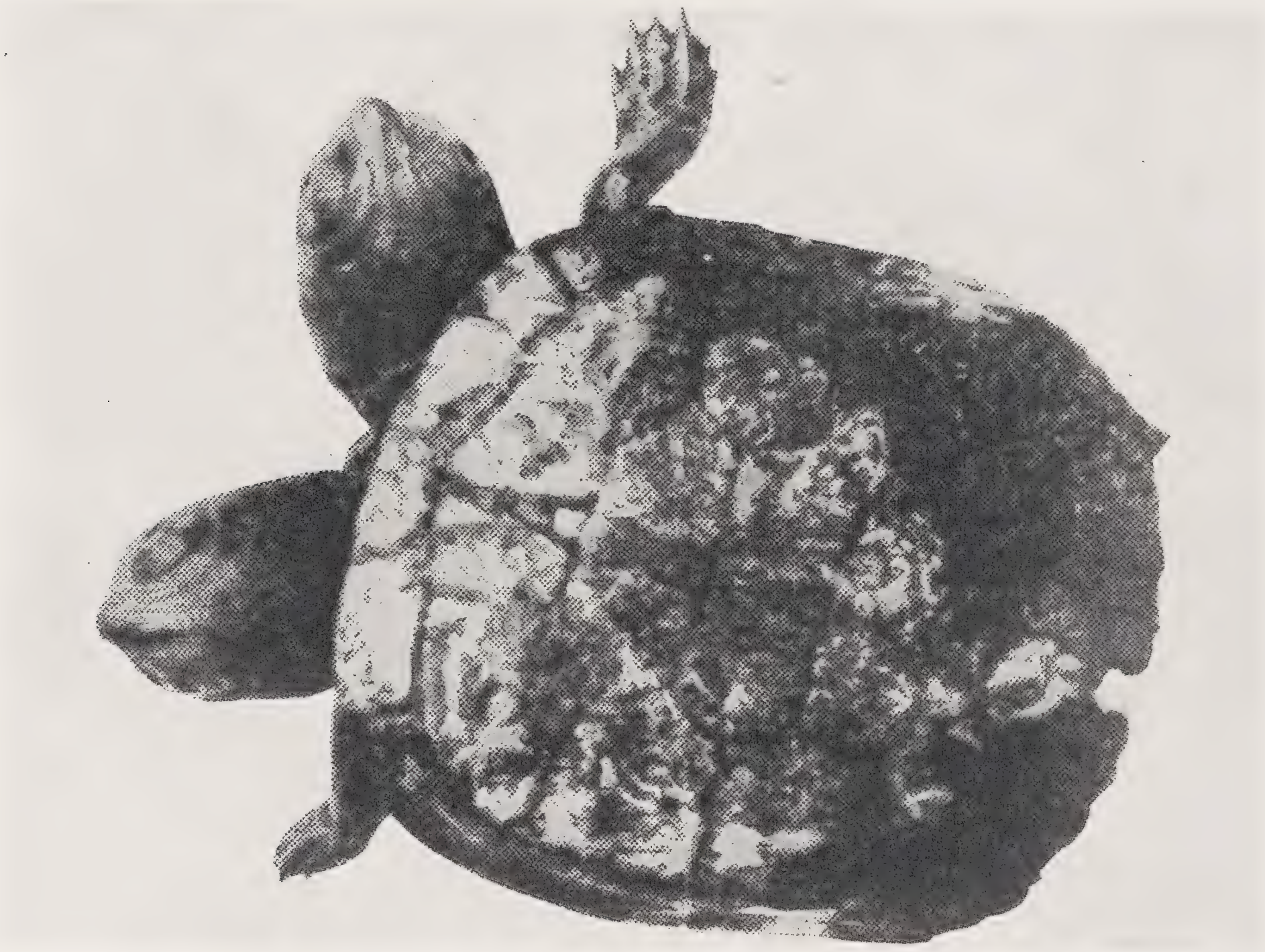


Sea-horse sculpture. These sea-horse figures modeled in clay are to be reproduced in terra cotta of a golden color and affixed to the wall of the Aquarium just above the entrance to the building. The sculpture as a whole measures roughly three and a half feet in diameter and will occupy a vacant lunette measuring seven and one-half feet in width by five feet in height. The modeling in clay was done by Gertrude Boyle after a design by the Director of the Aquarium.

the time. The birds were no more to be numbered than "the innumerable company of the stars." The sea was smooth and the *Albatross* was making about eight knots through the bird-covered area, which extended as far on both sides as it was possible to see from the top-sail yard. It was "Alaska weather"—inclined to be hazy and the horizon not very clear. Immediately ahead the birds kept rising and moving out of the ship's course. The rather narrow belts that were disturbed on either side rose and moved forward, joining the continuous flight of those ahead, which gradually tended to windward toward the left. The log of the *Albatross* might show how long we were crossing the avian galaxy. It would be worth looking up.

It was not my destiny to go very deeply

into ornithology. The long voyages with Agassiz, always illuminated with his enthusiastic talk in the ship's laboratory, amounted to a course in oceanography, which tended away from ornithology and eventually anchored me at the Aquarium. In this fishy atmosphere only the sea birds, pelicans, gulls, and penguins remain.



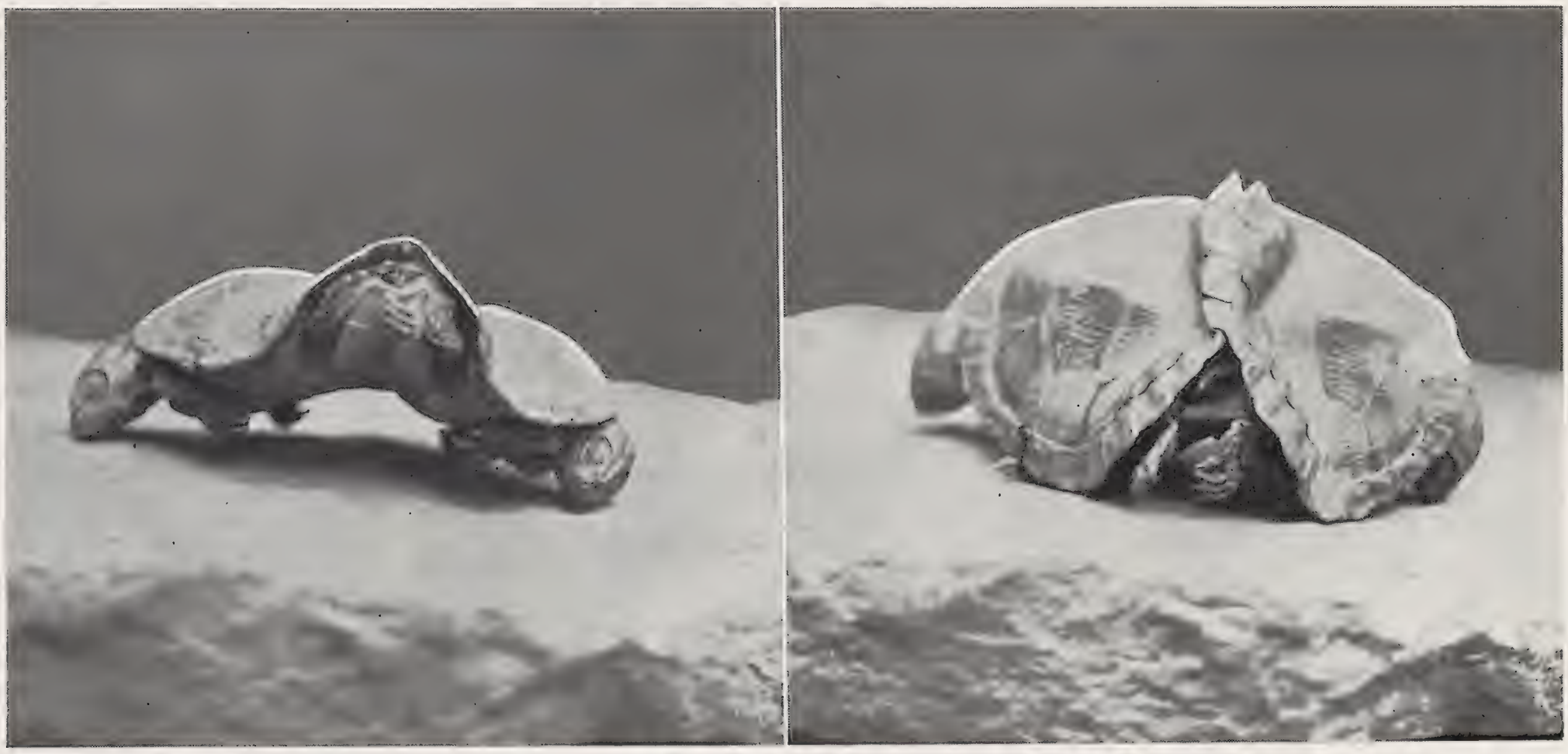
A double turtle that was found in Cuba. Reproduced from the Havana *El Mundo*.

A DOUBLE TURTLE

By CHARLES H. TOWNSEND

IN the December number of the *Scientific Monthly*, Professor S. Hoffman Derickson describes and figures a young twin turtle (*Chrysemys picta*) having two separate heads and necks. The dorsal region consists of two carapaces united laterally, the margins of which form a median ridge. The ventral portion of the body shows little evidence of twinning. This twin turtle has four legs.

Many years ago I was given the photographs published herewith, which show a young twin turtle whose two nearly perfect carapaces and plastrons are united posteriorly. The heads and fore legs appear to be normal, while the hind legs are developed on one side only. The posterior margins of the carapaces unite in an upward projecting but rather broken ridge, while the plastrons are united apparently very firmly, their union being depressed. There appears to be some indication of a tail on the side bearing hind legs. The united turtles were evidently dead and somewhat dried when the photographs were made. These photographs are now faded and dim and do not permit of a detailed description of the specimen comparable with that of the living twin turtle described by Professor Derickson, which lived three months. Nothing is known of its history except that the photographs were made at Warsaw, New York, at sometime prior to 1905 when I received them. A letter of inquiry



Young double turtle (Chrysemys picta?) left, lateral aspect; right, dorsal aspect.
Both photographs made by Otis of Warsaw, New York.

addressed to the professional photographer who made them, was returned from the post office at Warsaw.

In October, 1927, I received from Mr. Arturo Ojeda of Havana, a picture of a twin turtle published in *El Mundo,* a newspaper of that city. He identifies the species as *Emys descussata* from a Cuban stream and states that both heads with their eyes and tongues were functioning. This turtle was about a month old. The newspaper cut is reproduced herewith.

As Professor Derickson says, examples of twinning with various degrees of union of two individuals are not so common as to pass unnoticed.



Young double turtle (Chrysemys picta?) Ventral aspect. Photograph by Otis of Warsaw, New York.

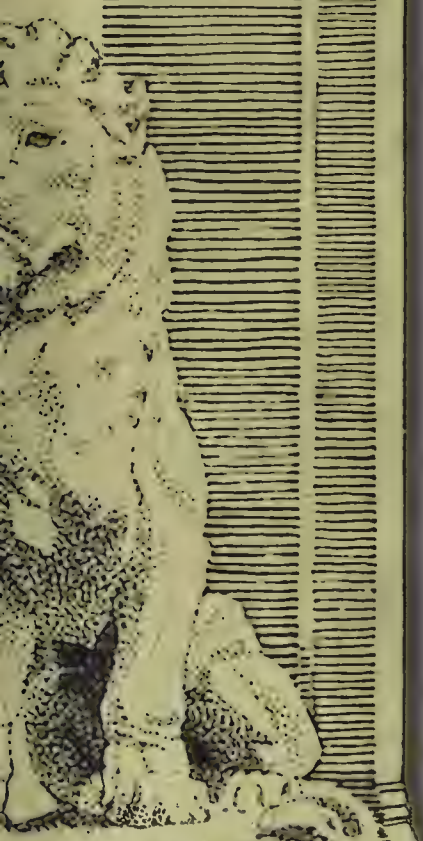
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NEW YORK ZOOLOGICAL SOCIETY



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FOUR COLOR CHANGES OF (*Sparisoma abildgaardi*) THE RED PARROT-FISH

Painted in the New York Aquarium by Hashime Murayama

THIS IS THE FOURTH OF A SERIES OF PAINTINGS ILLUSTRATIVE OF INSTANTANEOUS CHANGES IN COLOR AMONG FISHES, WHICH WILL APPEAR REGULARLY IN THE ZOOLOGICAL SOCIETY BULLETIN. THEY ARE TAKEN FROM A WORK ON THIS SUBJECT BY DR. C. H. TOWNSEND, NOW BEING PUBLISHED UNDER THE AUSPICES OF THE ZOOLOGICAL SOCIETY

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RECORDS OF COLOR CHANGES AMONG FISHES

IV. Four Color Changes of the Red Parrot-fish (Sparisoma abildgaardi)

By CHARLES H. TOWNSEND

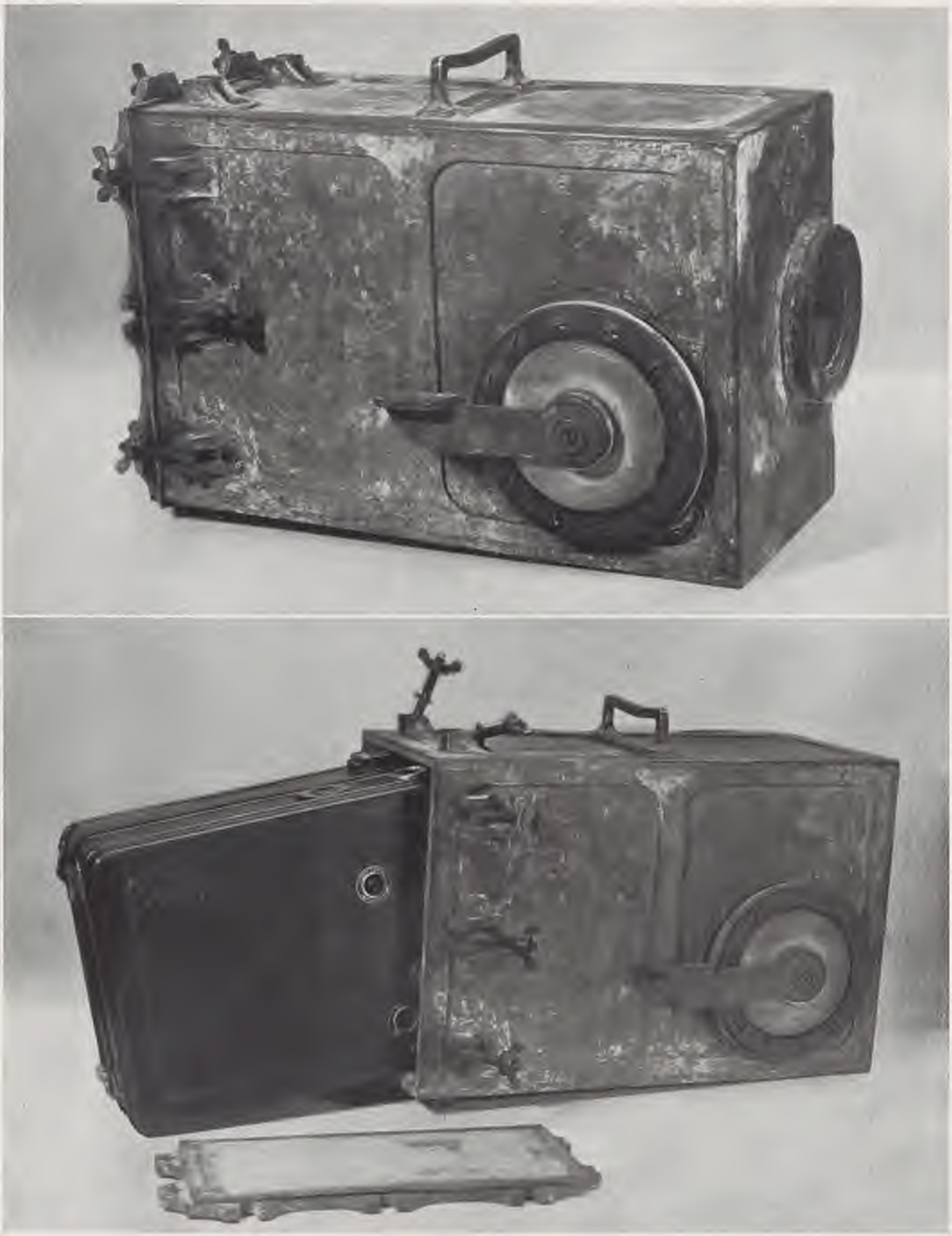
THE Red Parrot-fish (*Sparisoma abildgaardi*) is one of the most interesting among the species subject to sudden changes in color. The changes occur frequently when the fishes are in motion and are decidedly marked in character. In the brightest and most conspicuous phase there is a brilliant and nearly uniform red on the under surface and the lower fins. The color comes like a sudden blush, reaching its intensity in two or three seconds. The sides and the upper surface at the same time quickly turn very dark brown, especially on the margins of the scales, with the result that each scale is sharply outlined. In the second, fourth and sixth rows of scales, counting from the dorsal, each third, fourth or fifth scale in the row remains pure white, giving the fish about sixteen regularly distributed white spots which in the dark phase, are very distinct. The head and the dorsal fin quickly become darker; the pale pink of the tail turns crimson red, its pale bands becoming pure white. In this scarlet livery, with white trimmings, the red parrot-fish is a very showy creature. In its palest phase, the fish is almost colorless and nearly without markings, resembling a dead fish from which color has disappeared. In the dark phase, the swimming fish, especially if disturbed by its companions, will sometimes turn pale below, and the red wholly disappear, while the darkness of the upper parts will remain unchanged.

When the change from the dark to the pale phase takes place slowly—say, in five or six seconds—the obliteration of the different marks and colors can be easily followed with the eye. More often the change is instantaneous. When the two extremes of coloration are shown in separate fishes, as is often the case, the casual observer naturally supposes there are two species in the tank.

Between the extremes of coloration there are several intermediate phases, one of which is a pale fish, barely showing the white scales and the red underparts.

When in the half-pale phase, the rich brown color, white spots and gorgeous red can be produced instantly by disturbing the fish. Another phase is sometimes assumed when the fish is at rest, the dark upper color and the red under color being separated by a pure white band extending from the upper jaw through the eye to the lower half of the tail, the fringe of the opercle turning jet black. In still another, the tail turns white, and yellowish blotches appear on the head and on a few scales of the body.

The artist has not attempted to portray all of the color changes of which this fish is capable.



Brass Submarine Photographing Box. *Above*—The box closed, ready for lowering into the sea. *Below*—Open, showing the camera and closing mechanism.

A SUBMARINE MOTION PICTURE CAMERA

By JOHN TEE-VAN

General Assistant, Department of Tropical Research.

EVER since diving helmets were introduced as regular equipment of the Department of Tropical Research by Mr. William Beebe, practically every emergence from the water has been accompanied by a spoken or silent wish that the experiences and sights witnessed under the sea, might be recorded in some tangible way, and brought back to the many who have not been fortunate enough to go below the surface and witness the life that goes on there. These wishes were answered to a slight extent by the return last year of the Haitian Expedition bearing 1,200 feet of film taken below the surface, by Mr. Floyd Crosby, portraying the life of the coral reefs.

Submarine photography is such a recent matter, the first attempts having been made but thirty-five years ago, and of such unusual occurrence, that the apparatus employed in procuring the pictures is of more than passing interest.

As the work of the Haitian Expedition related almost entirely to the study of fishes and their habits, very little time could be devoted to photography alone. Under such conditions it was imperative that the underwater motion picture camera be simply made, easy to operate, not too large or heavy, and yet capable of doing the most exacting work under the surface, using sunlight only as an illuminant.

Such a camera was made before we left New York for Haiti as the result of plans worked out by Mr. William Beebe, Mr. Mark Barr and myself, the actual construction being in the hands of Mr. J. Schrope, foreman machinist of the American Museum of Natural History.

In brief, it consisted of a brass, water-tight case, into which a camera was inserted.

The camera chosen was a motor-driven De Vry, using standard 35. mm. film and equipped with its regular f. 3.5, two-inch focal length lens, and a two-inch f. 1.9 lens. It was selected after careful consideration of the smaller, motor-driven cameras mainly because of its shape—a rectangular box, about which it would be simple to fit a brass case. The choice was justified by the mechanical operation of the camera, as it performed perfectly and did everything that was required of it.

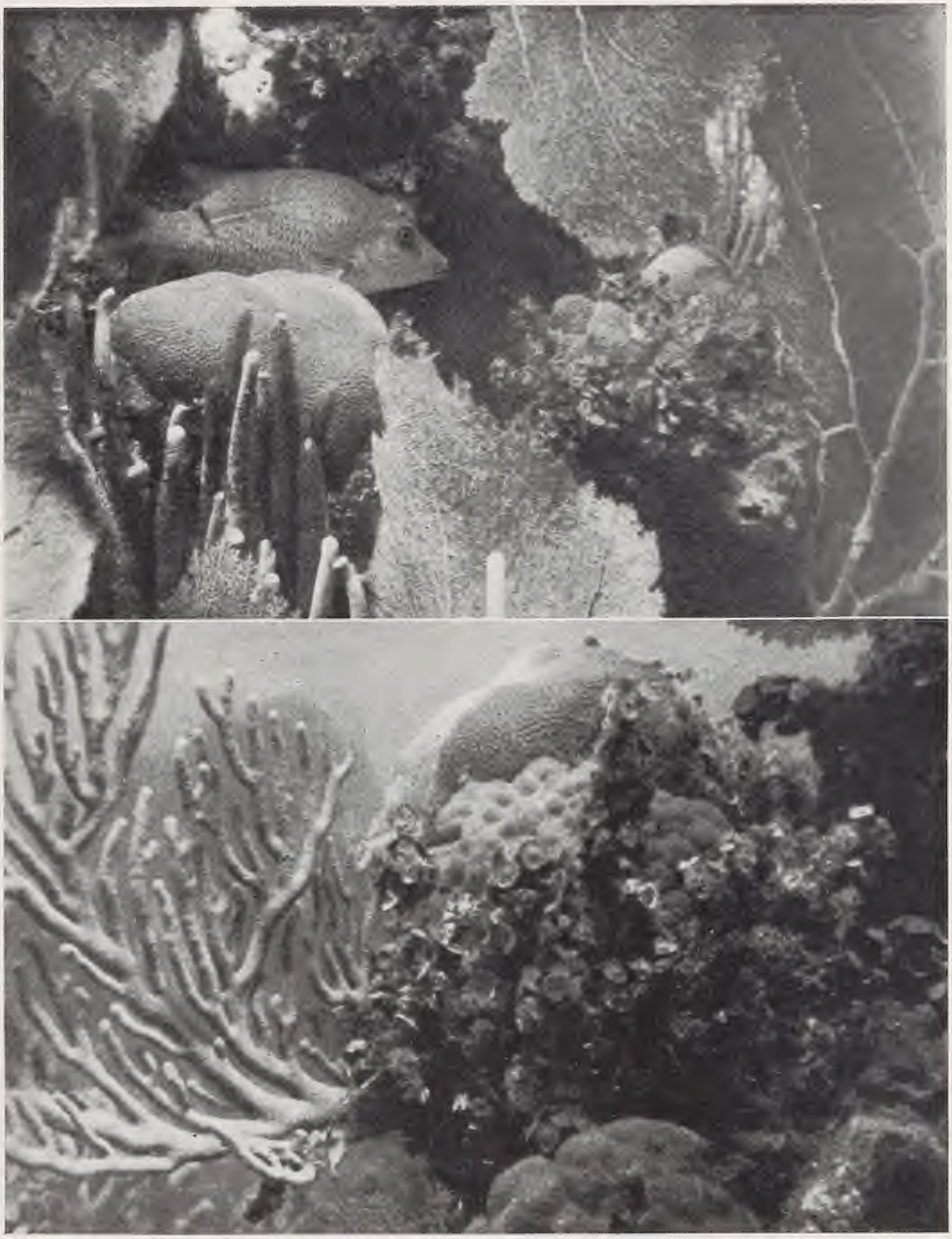
The outer, water-tight, brass case that allowed the camera to be taken below, can be more easily understood by reference to the illustrations. It consists of a rectangular box with outside dimensions as follows: length 12¼ inches, height 7⅞ inches, width 5¼ inches, made of ¼ inch thick brass, recessed on the sides and top wherever it could be done without weakening the structure, so as to lessen the weight as much as possible. The box and camera loaded with film and ready to go under the surface weighs 39 pounds.

The front end of the case contains a plate glass port 2 1/16 inches in diameter and ¼ inch thick, through which the photographs are taken. It is centered, of course, with the axis of the lenses and the center of the film. Space was left in front of the lens for filters, but they were not used during the expedition.

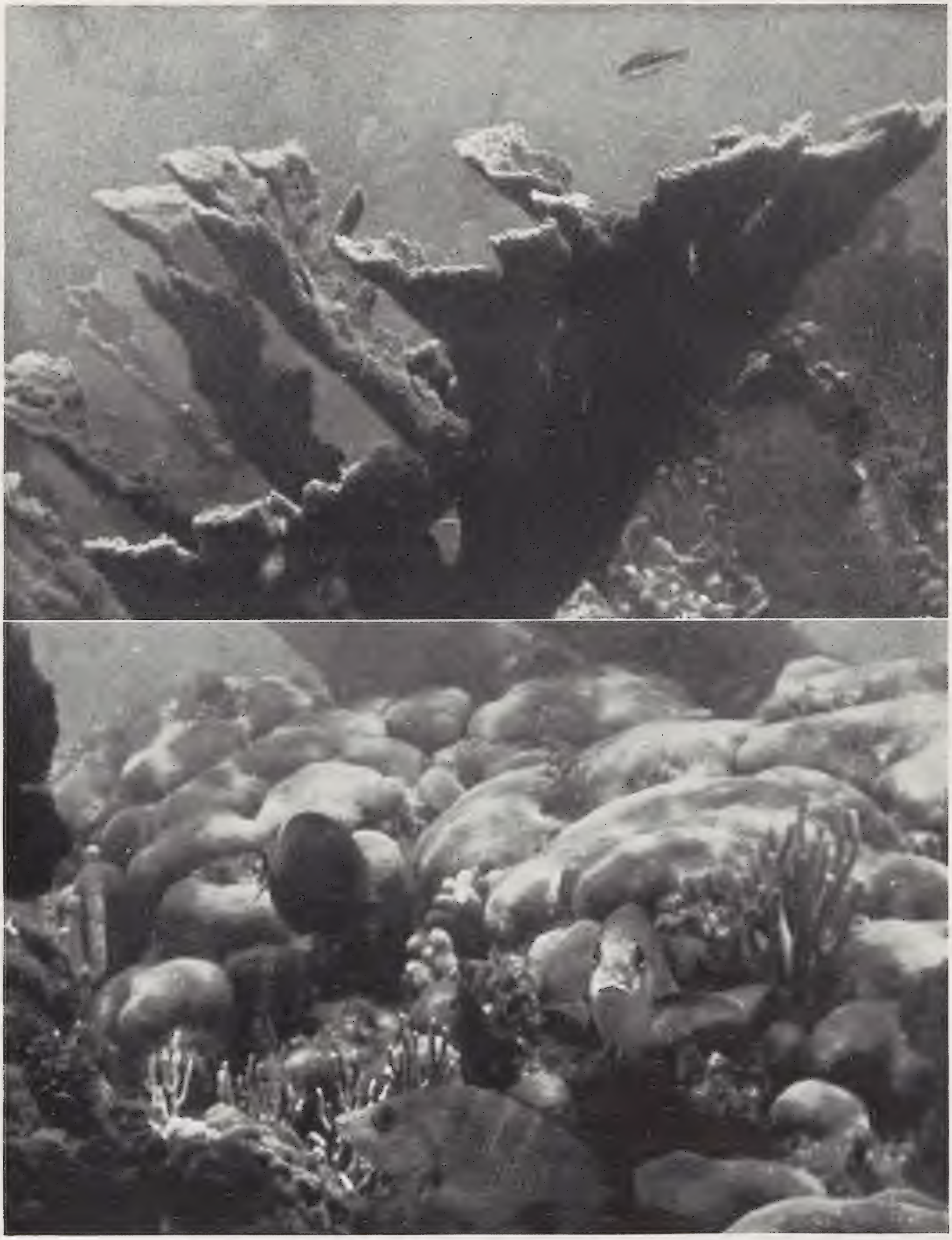
The rear end of the box is open so that the camera can be inserted. It is closed by a brass lid held tightly in place by ten butterfly-nuts—a large rubber gasket being inserted between the lid and the box, making the joint so tight that not a single drop of water entered the camera during the months that it was used in Haiti.

A small handle placed on top facilitated carrying the box and was of utmost importance in lowering the camera, by means of a rope to the diver.

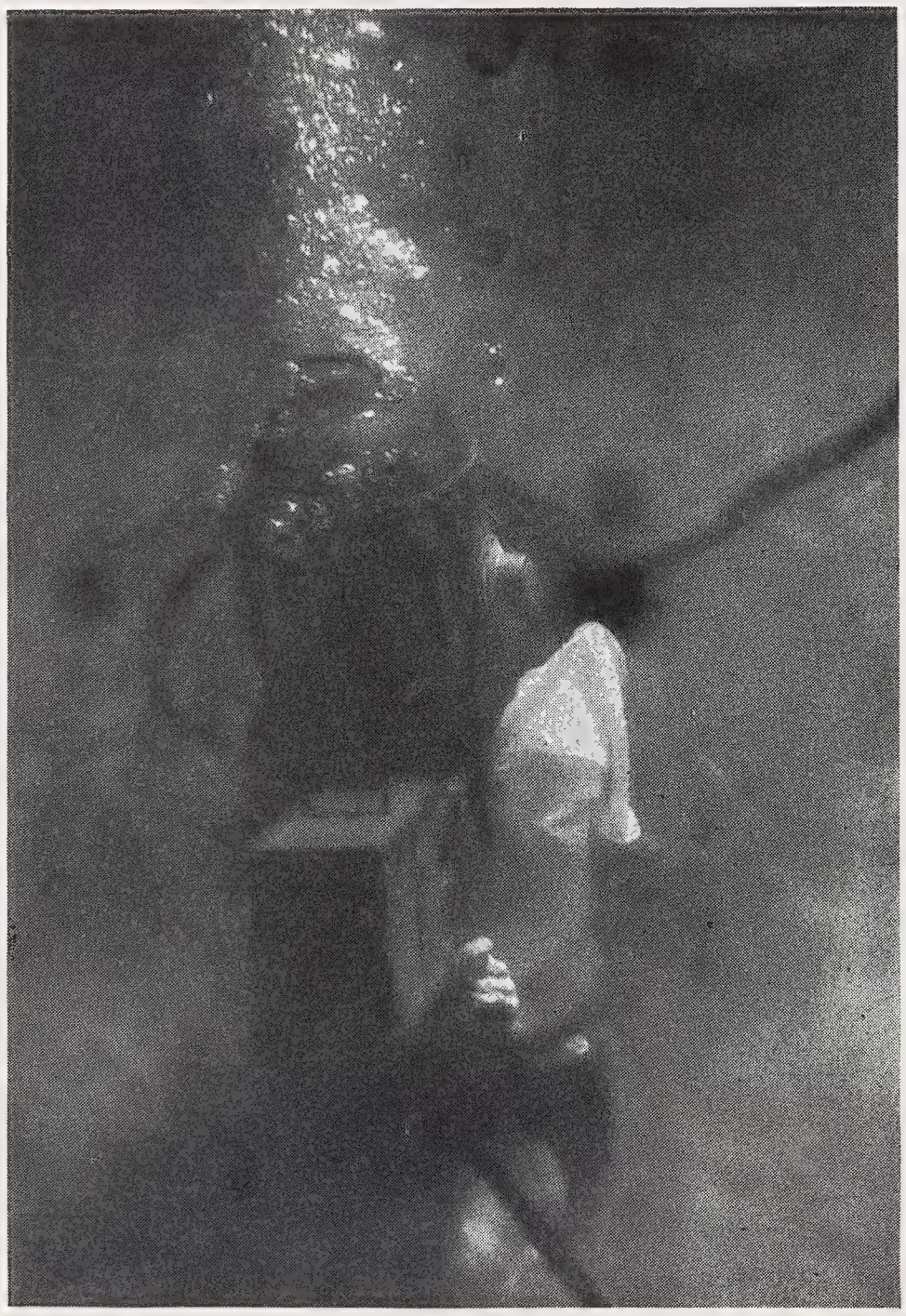
On the right side of the case is the lever which controls the starting and stopping of the camera. The lever shown in the photograph is one long bar of an elongated U, which is pivoted in the side of the camera at the base of the U. The other and inner long bar was forked at its distal end and fitted about the starting button of the camera. To make this possible, the starting button supplied with the camera was removed and one shaped like a flattened spool was fitted in its place so that it would slide between the two tines of the fork. Thus when the outer lever was pushed downward the starting button



Enlargements of Motion Picture Film taken on the coral reefs of Port-au-Prince Bay by Mr. Floyd Crosby. Snappers play about among the brain corals, disappearing from view as the sea-fans, like great elephant's ears, wave slowly to and fro.



Above—Palmate coral with small parrot fish.
Below—Surgeon fish and schoolmaster snappers.



The submarine camera in ten feet of water.

moved down and the camera photographed, and when it was pushed upward it stopped.

Because the starting lever did not move more than 3/8 of an inch at its outer end, it was decided that all the motion could be taken up by utilizing the stretching qualities of a large disk of heavy rubber, and that it was unnecessary to make a stuffing box to avoid leaks at the joint. This disk, as can be seen in the photographs, was held in place with the aid of a brass ring, and firmly cemented to the case at its periphery. At its center, it was cemented between and held in place by large flat washers, the lowermost part of which was part of the bottom of the U. Thus when the starting lever moved downward the rubber merely stretched a little around the circle. This joint, as can be seen is simple and fool-proof, the only possibility of a leak being through the rubber, and when two sheets are used the likelihood of this happening is not very great.

As the camera box is not a perfect rectangle, having protuberances such as starting buttons, finders, etc., it does not fit the box exactly. To prevent the camera rattling, thick pieces of rubber, an inch wide and half inch thick and as long as necessary were inserted on the sides and top. These were removed every time the camera was taken out of the case, but they are now being incorporated as part of the brass box.

Using the camera in the field usually resolved itself into the following procedure. A reef having been found where conditions such as adequate scenic effects and sufficient numbers of fish could be found, the photographer went down in his helmet and selected a suitable background or place to photograph. After choosing the spot he measured off the distance to where the camera was to be placed, appraised the amount of light, and ascended to the surface. The camera was then loaded with film, wound up, the lens set, because of the refraction of the water, to two-thirds the distance measured below, and the diaphragm adjusted to whatever aperture was considered necessary.

The diaphragm setting employed during most of our photography at depths of 8 to 15 feet between the hours of 10.30 and 1.30 with bright sun as near overhead as it could be, was between f. 5.3 and f. 8 using f. 3.5 lens. Although we possessed a lens with an aperture of f. 1.9 we found that fully exposed negatives were obtained using the exposure mentioned. The speed of the camera, of course, was standard—16 exposures a second.

After the adjustments were made, the photographer descended and the camera was lowered to him. He then placed it on a tripod having a metal top—the metal being mostly to prevent the tripod floating away. The fish were baited if it was necessary to concentrate them in one spot, and the photographer pressed the lever whenever he felt that it was worth while. The absence of the slight vibration of the camera indicated when the spring had run down and the camera stopped. It was then sent to the surface, rewound or new film inserted if necessary, and again sent below. The camera contained 100 feet of film and ran for 50 feet on one winding.

Panchromatic film was used, without filters, for under water work—the film being supplied with extra long red leaders and tail pieces. Although these made the film supposedly day-

light loading, we took no chances and always used a loading bag.

In the waters about Port-au-Prince we found that beyond twenty-five feet from the camera, the haze in the water was too great to pick up more than vague outlines on the film. In clearer water, further distance might easily be attained.

After using this camera under water for four months, certain suggestions regarding improvements can be made. Two of these, of little importance, are to make the handle on the top larger, so that four fingers could grip it, and make the butterfly-nuts on the rear lid larger. With fingers wet and drawn and sensitive after a few hours of diving, tightening the small nuts brought about a considerable amount of profanity that might easily be obviated.

A third improvement, of greater consequence, would be to make a finder that would fit on the upper surface of the case or on the left hand side that would indicate the field visible on the film. After a certain amount of experience it is fairly easy to operate the camera without the finder, but having one would simplify matters. The making of this finder is not as easy as it appears to be. This is so first, because the diving helmet does not allow the wearer's head to come as close to the camera as it would in the open air, and lining up two points is a slightly greater task than it is above water and secondly the refraction of the water must be taken into account.

As can be seen, the apparatus is as simple as it could possibly be, and the resulting photographs have proved of great beauty and of real scientific worth. It is hoped that this simplicity will induce more people to descend and photograph and bring back records of the only other world from which we who live on earth, can return.

RIDDING PONDS AND LAKES OF EXCESS VEGETATION

By IDA MELLEN

GARDEN pools sometimes become so overgrown with microscopic floating algae that the water is green. The best way to clear it is to introduce a few Daphnia to eat it up. These small crustaceans can either be collected from some wild pond or purchased from breeders of fancy fishes. A dozen Daphina will produce millions in a few days and within a week the water in the pool will be clear. Fishes prey upon the Daphnia and to insure the success of the experiment it is best to remove them temporarily, to give the Daphnia full sway.

Another method is to darken the pool, as the algae grow only in light. This can be accomplished by laying planks or stretching clean burlap over it. Fishes are not injured by being kept in the dark for a few days.

If the pool is shaded by trees and bushes, or well planted with water lillies, there is generally no trouble with floating algae.

Ponds that become overgrown with water weeds may be rid of the obnoxious growth in several ways, as follows:

1. Carps may be introduced. They can be purchased from live-fish dealers. These fishes are vegetable eaters and will uproot and consume the vegetation. If desired, they may be seined out when their work is done.

2. A scythe can be used to cut off large, rooted plants. They should be cut as far under water as possible and it may be necessary to cut them a second and third time before the stems and leaves have a chance to grow above water. To cut plants can be raked from the pond. After a third cutting the plants die from lack of air, and in the fall, after the pond is drained or the water dried up, a plow may be used to carry them away. A scraper will also remove seeds. Freezing destroys some of the vegetation.

3. A rake attached to a float is sometimes employed successfully in the destruction of plants in small ponds.

4. Rope and wire dragged through the water will uproot the vegetation.

Lakes, if not too large, can be rid of excess vegetation by one of the foregoing methods.

Copper sulphate is effective in the destruction of microscopic plants. The same strength of solution will not kill all algae, some species being destroyed by a solution of 1 part copper sulphate to 12,600,000 parts water, while others do not succumb in a solution less strong than 1 part copper sulphate to 20,000 parts water.

Fishes, like plants, show varying degrees of resistance to this chemical. Some species, such as goldfishes and minnows, can resist a solution of one part copper sulphate to 200,000 parts water, while carps, yellow perch and catfish die in a solution of one part copper sulphate to 500,000 parts water. Black bass can tolerate a strength as great as one part copper sulphate to 50,000 parts water. The method commonly employed is to go out in a boat and drag a bag of the copper sulphate through the water, repeating this the day following if necessary. To make a solution of one part copper sulphate to 200,000 parts water, one would use one gill copper sulphate to every 6,250 gallons of water. The New York City Water Department uses only one-half part copper sulphate to 1,000,000 parts water for the destruction of microscopic plants and animals.

If the pond is large and water weeds interfere with boating and bathing, under-water weed-cutters serve the purpose. They consist of a motor boat with a large, specially designed sickle attached.

(Information as to where to purchase live carps and weed-cutters, will be given on request.)

NOTE.—The foregoing will be published as Information Circular No. 12, for free distribution to people having trouble with excess vegetation in their ponds and lakes.



Ten Pound Island Fish Hatchery. At the left, the coast guard station's giant hanger.
Photograph by Ida Mellen.

AN ISLAND FISH HATCHERY

By IDA MELLEN

OFF the coast of Gloucester, Massachusetts, lies Ten Pound Island. By some accounts its name was derived from the fact that the Indians sold it for ten pounds. This is difficult for a New Yorker to believe when he recalls that his big Manhattan Island sold for less than five pounds, and he is inclined to suspect that the name was given by some early angler who caught a ten pound fish there. However it came by its name is immaterial; the little island, used only for Government purposes, is crammed full of interest for the visitor who is fortunate enough to set foot on it.

Through the courtesy of the Frank E. Davis Fish Company, whose spotless factory is one of the proud spots of old Gloucester, a telephone communication was sent which resulted in an arrangement being made to convey the writer to Ten Pound Island. Mr. Clifford G. Corliss, in charge of the United States Bureau of Fisheries' hatchery there, himself came to Gloucester in the hatchery's motor boat, to see me across and tell something about the work of the station.

In the summer season the hatchery is a quiet place excepting for the whirring of grasshoppers' wings that keep the air moving.



A spawntaker preparing to open a freshly-caught codfish to save its eggs.
Courtesy Bureau of Fisheries, Gloucester, Mass.



Pressing out the eggs into the receiving can. Courtesy Bureau of Fisheries, Gloucester, Mass.

There appears to be at least one grasshopper for every blade of grass. The chief beauty of the spot is in Mr. Corliss' dahlias, some of which are as big as dinner plates.

Near the hatchery a coast guard station has been built by some of the most skilled mechanics in the country, and the giant hangar, accommodating four hydroplanes, is a great credit to these men and also to the Government. One could spend hours admiring all its accoutrements.

In the winter the hatchery becomes a bustling scene when billions of eggs are in process of incubation and the flowing of water in the many tanks makes it a noisy place indeed. The telephone bell is the size of a fire gong and terrifying when it goes off in the still summer air. In the busy season it is merely one of the few sounds that can be heard above the noise of the water.

This station of the Bureau of Fisheries is an important one for our Massachusetts fishermen, for it is one of the stations devoted to the conservation of the cod, haddock and pollock, and, to a lesser extent, the flounder.

These are winter-breeding fishes, and it is no idle and luxurious life gathering their eggs. The spawn-takers, four to eight in number set out at four o'clock in the morning on the gill net and secure the eggs and milt from the freshly caught fishes. Often the decks are covered with ice and snow, the wind is high, and the weather bitter cold, while they are busy stripping fishes and fertilizing the eggs.

Fishing in the waters of Cape Ann is so intensive that it is remarkable how any fish escapes the nets. Three years ago it was prophesied that four years would end local fishing, but it is still going strong, and the hardships of the work of conservation seem compensated for when the results are so apparent.

Besides Mr. Corliss and the spawn-takers, the station employs an engineer, three firemen, a cook and five hatcherymen; that is to say, eleven people in the hatchery and from four to eight in the field.

Codfishes spawn several times in a season, laying from 600,000 to two or three million eggs. Cod eggs are hardy. They measure one eighteenth of an inch in diameter and a quart measure holds 336,768 of them.

The eggs or the haddock and pollock are delicate and difficult to handle, especially in their early stages. Haddock eggs measure one-seventeenth of an inch in diameter, while pollock eggs are as small as one-twenty-second- of an inch. The eggs of these three fishes will float in pure sea water, but low density causes them to sink.

There is an immense amount of fresh water flowing into the sea from Cape Ann, as one will notice if he walks along the beaches; and on this account the eggs of some sea fishes such as the cod do better if planted directly in the ocean. In other words, it does not always agree with the fry to be transferred to brackish water from the pure sea water of the hatchery.

Out of 789,158,000 cod eggs taken last season, Mr. Corliss had 586,000,000 planted directly in the sea, the hatchery turning out but 158,000,000 fry.

Of 339,651,000 haddock eggs taken last season, 231,407,000 were planted directly in the sea on account of the low density of the water, and 63,894,000 fry were hatched and planted.

Of pollock, 1,048,534,000 eggs were taken last season, and 638,000,000 were hatched. The pollock eggs taken number from 10,000,000 to 150,000,000 a day, and on one occasion numbered 180,000,000.

The men often work in the hatchery from twelve o'clock noon until midnight, measuring the eggs and placing them in MacDonald tidal boxes. These boxes, used by the Bureau of Fisheries, are so ingeniously made that the water rises and falls in them, simulating the tides in the ocean. Each box accommodates 1,000,000 eggs and there are nearly 300 of the boxes ranged on long tables at the Ten Pound Island station.

Now the case of the flatfish is quite different. These fishes are not taken in gill nets, but in fyke nets, and are conveyed alive and in good condition to the hatchery, thirty to fifty a day, and sometimes four to five hundred in a day. They are deposited in brood boxes, where they spawn naturally. Spawning is accompanied by a great commotion and splashing of water, and occurs about five o'clock in the morning.

When Mr. Corliss said, "We do not do a great deal of flounder hatching, the number of eggs hatched last year being only about 170,000,000," he gave an idea of the vast figures with which he has to deal.

The lobster no longer receives protection from the Government, which was surprising news, for lobster fishermen generally disregard the laws prohibiting the taking of undersized specimens and of female lobsters in berry, and it would seem inevitable that this succulent "shellfish," in the absence of protection, is doomed to become extinct through over-fishing; or should we say through over-popularity?

If one were to go prepared for the rigors of the New England winter, it surely would be far more interesting than all the winter sports to witness the work of the spawn-takers of Ten Pound Island on a fierce December day at four o'clock in the morning.

A NEW BOOK ON TOY FISHES*

THE first bound volume to be devoted exclusively to the subject of tropical toy fishes is entitled Tropical Aquarium Fishes and comes from the pen of Mr. A. E. Hodge of London.

Mr. Hodge is president of the British Aquarists' Association, editor of The Amateur Aquarist and Reptilian Review, and author of Vivarium and Aquarium Keeping for Amateurs, and Goldfish Culture for Amateurs.

The book is illustrated, and besides covering plants and snails and advice on the care of an aquarium and its inmates, incorporates, as a "general survey," Catalog of the Principal Aquarium Fishes prepared by Mr. George S. Myers of Stanford University. This was published in the United States in pamphlet form and covers about ten families and nearly twenty species of tropical toy fishes which are commonly introduced into England and the United States from Asia, Mexico, South America and other warm countries, besides some that are found in the United States. Mr. Hodge, in addition, specifically describes from his own careful observations the habits of a number of the commoner varieties.—I. M.

* Tropical Aquarium Fishes, by A. E. Hodge, Frederick A. Stokes Co., New York, $2.50.

THE DRAGONFLIES (Odonata)

By IDA MELLEN

LAST summer an artist sat sketching a mill pond. He saw the glassy surface of the pond and its water flowing to the sea; he saw the willows and the ice houses reflected in this shining mirror; and he saw the little fishes jump out of the water as the big ones pursued them, creating wide ripples. But at his feet, in the quiet shallows, he did not see the scarlet water mites or the blue dragonflies —and these were most wonderful of all.

The mites were running about over the submerged stones, engaged at nothing in particular, but it was the wedding day of the blue dragons and hundreds of them were busily mating and laying their eggs. The water was tinted by the pure sky blue of their wings and bodies. The males, by means of the clasping appendages at the ends of their bodies, grasped the females by the head; and this was a signal for the females to curve their slender bodies forward until their eggs were fertilized. The males kept well above the water and their wings whirred hard and fast, while they retained their hold upon the heads of the females to permit them to deposit their precious eggs just beneath the surface film without wetting their wings.

Even the naturalist who, along with the red dragons, was an accidental guest at the wedding of the blue dragons, did not see the mass of tiny eggs sinking slowly down into the mud at the bottom of the pond, where, if fortune attended them, they hatched in the autumn to come forth next summer as mature blue dragons.

Now, there are many species of dragonflies —hundreds have been recognized—and many are gorgeously colored, or striped with green or yellow, while some are sombre brown or gray. Their life history is much the same. The eggs are laid singly or in groups, and from them the larvae hatch, equipped for life under water. In some of the larger species the larval existence covers a period of two or three years, but in most it lasts not above eleven months. The larvae are provided with a queer, protrusible apparatus called a "mask." It resembles a pair of ice tongs at the end of a long, broad arm. Reaching out with this



Transition of a dragonfly from aquatic to terrestrial life. The winged insect has just emerged from its larval case, to which the tip of its tail still adheres. In the struggle, the case has been dislodged from the stem to which it was clinging. Photograph by Ida Mellen.

serviceable device, they seldom miss their prey, which consists of their own kind and the larvae of other aquatic insects including mosquitoes, also young fishes, tadpoles, worms and crustaceans. In an experiment made by the writer, it was discovered that a young dragonfly larva in twenty-four hours could comfortably make away with thirty-nine tadpoles each about an inch long.

The victim, grasped securely in the tongs, is carried alive to the dragon's mouth and nibbled in much the same way that a child nibbles a banana held in the fingers.

In the practise of head-hunting, the dragonfly larvae seem to have been among the earliest pioneers. If we place a number together in a jar, we shall soon find most of our captives lacking that important member. The insect head-hunters do not preserve their captures as trophies, as human head-hunters do, but promptly eat them.

The wedding of the dragonflies is an impressive event, but the transition of these insects from the aquatic, larval stage to the terrestrial, egg-laying existence, is truly awe-inspiring. There is no pupal stage for the dragons; they molt a number of times, tiny wing stumps appearing at the third or fourth molt, and finally they pass directly from the comparatively sluggish but voracious larvae—called also nymphs—to the active and equally voracious winged adults—called also imagos.

The dragonfly larva climbs out of the water, either by way of some projecting twig or leaf, or directly onto the embankment, and from a small split in its back its new self emerges. The new self is as unlike the old as a butterfly is unlike a caterpillar. In place of the stubby body, the small head and dull eyes, there emerge a large head with enormous, bright faceted eyes, a long, slender body, and large, delicate wings. Slowly the moist, crumpled wings—four in number—are unfolded and pushed out to their full length, like a tape measure from its case, both wings and body elongating in a short time as one watches this marvelous rebirth.

It is an exhausting process, particularly the extricating of the legs, and some of the dragons die from fatigue. If all goes well, however, they dry their wings and after a complete rest set out in search of insect prey, which, as their popular name of "mosquito hawks" indicates, includes their ancient victims the mosquitoes, these meantime having also acquired wings. They also prey on moths and butterflies, gnats and flies, capturing the prey while on the wing. This is done with such rapidity that no accurate observations have been made, but it appears that the six legs are used as a combined net and trap, striking out and capturing the victim, which is instantly conveyed to the mouth, where the strong teeth make short work of it. In the tropics the dragons are especially beneficial to man, destroying myriads of mosquitoes. A dragonfly can pack one hundred mosquitoes into its mouth at one time. The only charge against the dragons is that they sometimes destroy a queen bee during her nuptial flight, which is a considerable loss to the bee keeper. On the other hand, the dragons have their enemies, according to the

principle of this old world of give and take. Under water they fall prey to diving beetles and their predaceous larvae, spiders, water-diving birds, water snakes, salamanders and fishes, and on the wing they are captured by flickers and hawks and other birds, and sometimes killed by people who are ignorant of their great value as destroyers of insect pests.

Some species swarm and migrate, but it is not known whether any of the adults hibernate over the winter. It seems more reasonable to assume that they live but a few weeks or a few months, depending upon the time they emerge from the larval case. From spring to early fall the winged insects are emerging every day. They revel in the hot sunshine, destroy innumerable insects, mate, deposit their eggs—and disappear.

During the remote period of gigantic insects, dragonflies larger than the largest flying fishes of the present day, with a wing spread of two feet and heads as big as a man's fist, winged their hungry way over the tropic swamps. They were miniatures of the first French monoplane, which was designed on a dragonfly model. The dragons fly faster than any other insect, and make a sharper, shorter turn than any other creature on wings.

ITEMS OF INTEREST

U. S. Department of Agriculture

Wild-Life Problems.—To protect the lives of the useful or harmless wild animals and birds of the country and at the same time to guard growing crops and livestock against depredations of injurious wild life is the complex problem in conservation which the Bureau of Biological Survey[1] is constantly facing and attempting to solve. This service is becoming more important as time goes on and the scope of its organization is enlarging accordingly.

The increasing occupation and development of the United States makes it increasingly difficult to maintain even a fair representation of the once enormous natural resources in game and fur-bearing animals and game and insectivorous birds in this country. At the same time, the wide-spread herds of domestic stock and the extension of the farming areas have given predatory animals and harmful rodents of many species an abundant food supply, under the influence of which their numbers increase and necessitate active control.

To accomplish the varied tasks involved in these problems calls for field and laboratory investigational work by trained specialists, and the maintenance of warden service to safeguard Federal wild-life refuges and to enforce Federal game laws, as well as a force to conduct field campaigns to control wild animal and occasional bird pests.

The economic phases of the Bureau's work have included operations for the control of predatory animals, chiefly in the West. That predatory animals have been considerably reduced in numbers is shown by the fact that a total of 352 wolves, 37,255 coyotes, 228 mountain lions, 2,945 bobcats, and 61 Canada lynxes were taken. In addition probably twice as many coyotes were killed in poisoning campaigns. Measures to reduce the numbers of coyotes and bobcats have also served to check the spread of rabies, which is carried by these animals. In cooperation with State extension services and other State and private organizations, constant warfare is waged by the Biological Survey against injurious rodents, which consume vast quantities of grain and grasses in the West.

The study and conservation of fur-bearing animals, for many years one of the projects of the Bureau, has been designated as a separate division of fur resources. Under this division an experimental fur farm is maintained at Saratoga Springs, New York, for investigational work in the propagation of fur-bearing animals in captivity.

The Alaska Game Law, passed by the last session of the 68th Congress, provided for the establishment of an Alaska Game Commission of five members, all residents of Alaska, and one of them the chief representative of the Biological Survey in the Territory. The resident commissioners appointed by the Secretary of Agriculture to enforce the law and the regulations promulgated by him will have available for their use the vast store of information on birds and mammals in the files of the department and the cooperation of the Biological Survey.

The appropriation of funds by Congress for the establishment of the Upper Mississippi River Wild Life and Fish Refuge, extending for about 300 miles between Rock Island, Illinois, and Wabasha, Minnesota, has brought the number of Federal wild-life reservations under the jurisdiction of the Biological Survey to

[1] Report U. S. Bureau Biological Survey.

seventy. These refuges and preserves for wild birds and animals are distributed over the United States, and in Porto Rico, Hawaii, and Alaska, and constitute an extensive phase of the conservation work of the Buerau.

Encourage Vireos.—During the summer almost anywhere in the United States at least one species of vireo, and usually more than one, is to be found flitting about in the trees or shrubbery. In the East and Central regions the common species is the red-eyed vireo, but the white-eyed, warbling, and yellow-throated vireos also are abundant. The Philadelphia, blue-headed, Hutton, and Bell vireos are more or less widely distributed. As with other common species of birds, the question as to whether or not vireos are beneficial is legitimately raised, and to answer it, the Biological Survey[3] has made a study of their food habits.

The food of the several vireos is shown to be very similar though sometimes varying in proportions. Most of the insects eaten are either neutral or definitely injurious in their economic relations, and may be placed on the credit side of the account of these birds. All vireos are especially fond of caterpillars. Scale insects are a notable item of vireo food, and other tree pests are freely eaten. Many destructive weevils were found in the stomachs examined, including such forms as the clover-leaf, clover-root, cotton-boll, and nut weevils, the plum curculio and bark beetles. Vireos also destroy ants and grasshoppers. Useful insects taken by the vireos include some of the hymenopterans, predacious bugs, and beetles, among which are ladybird beetles, which are almost uniformly beneficial. Although it is regretted that vireos consume as many ladybirds as the evidence indicates, yet they also devour many of the pests attacked by the ladybirds, which must, in part excuse them. As fruit eaters the vireos are practically harmless.

Blue-Fox Farming.—Raising blue foxes for their pelts is becoming an important enterprise on the islands along the southern coast of Alaska, according to a recent bulletin of the Biological Survey[4] and so rapidly has the industry grown that practically all suitable islands controlled by the Department already have been leased for this purpose. Blue-fox farming is practiced on outlying islands that are of little or no value for agriculture, and the foxes are allowed to roam over an entire island, where they choose their mates and make dens. The animals are, in most instances, fed at regular intervals by the ranchers.

Attempt to raise blue foxes in pens in Alaska have met with some success, but it is claimed by a number of ranchers and raw-fur buyers that the pelts of blue foxes thus raised lack the quality and finish of those produced under wild conditions.

A long, cold winter with a fair amount of rainfall, particularly in spring, conducive to the production of good pelts. An island chosen for a fox ranch should have a harbor for a boat to permit communication with the mainland or other islands. Since fish is the chief article of food in the diet of the blue fox, proximity to a cannery is of decided advantage, as the waste material makes excellent feed for the foxes, and fresh-water springs, streams, or ponds on the island ranch are also important.

Selective breeding of the animals is recommended as a means of improving the market value of the pelts.

That the white fox will play an important part in fox farming is indicated by the fact that of ninety-two permits issued in 1925 by the department for the capture of Alaskan fur bearers for propagation, thirty-three were for taking white foxes.

The bulletin contains much valuable information relating to blue-fox farming, on the selection of ranch sites, breeding, feeding, transportation, characteristics of good pelts, sanitation and treatment of diseases, and reasons for failures.

Game Protection Directory.—For the convenience of game authorities, bird-protection organizations, and others in procuring information concerning game and game laws, a circular has been issued by the Bureau of Biological Survey.[5] The organization and personnel of governmental establishments in this country, Canada, and Mexico concerned with game matters are given, together with the names and addresses of officials of State-wide game and bird protective associations and societies, and of the principal national organizations interested in bird protection, including the advisory board, migratory-bird treaty act.

[3] Food Habits of the Vireos.

[4] Blue-Fox Farming in Alaska.

[5] Directory of Officials and Organizations concerned with the Protection of Birds and Game.

For [1, 2, 3. 4, 5] address U. S. Department of Agriculture, Washington, D. C.

Legislative changes affecting game administration made during the year are noted, especially the appointment of the Alaska Game Commission of five members.

HELP US TO BE PUNCTUAL*

Accuracy of Timepieces Depends Largely on Porpoise Jaw Oil

EVER since the clock, as we understand it today, came into being, the problem of proper lubrication has been an ever-present one with the watchmaker. Each improvement in the delicate moving parts has added to the difficulties by making still more necessary the employment of a lubricant which would reduce the friction of those parts to the lowest practicable minimum.

If too thin the oil would be apt to "creep" or work away from the pinion and the bearing where its presence was essential; if too thick it would just as certainly clog or act as a brake at these very sensitive points of contact. In short, the ideal oil is one that remains fluid throughout a wide range of temperature and yet is sufficiently stable to stay where put and to do the work expected of it. Strange as it may seem, only one kind of oil has so far been discovered which, when properly refined, will measure up to these exacting requirements; and that is the oil which is extracted from the jaw pans of the porpoise—a playful creature, utterly unmindful of the passage of time.

During the day we carry our watches close to our bodies and subject them to blood heat, while during our sleeping hours these timepieces may lie exposed to the chill night air that has dropped well below the freezing point. If we are commuters we may make or miss our morning trains because of the kind of oil the watchmaker has employed. The lubricant must be equally insensitive to heat or cold and not be apt to thin out when warmed up or to thicken and congeal when exposed to cold.

For many years porpoise fishing was a side issue or a mere incident to the garnering of other forms of sea life. Down East, along the coast of Maine, native Indians have been accustomed for decades to pursue porpoises deliberately—killing them by harpooning, and not infrequently mackerel fishermen have caught occasional porpoises in the course of their day's work.

But none of these sources of supply has been equal to the increasing demand for the desired oil. This situation became serious with the appearance of the cheap watch and the rapid multiplication of factories engaged in turning out alarm clocks of various degrees of excellence. Then it was that William F. Nye of New Bedford, Mass., took matters in hand and established a unique industry which would make certain of the capturing of an ample number of porpoises annually to meet the market needs. To supply the demand something like 3,000 of these miniature relatives of the whale must be caught every twelvemonth.

Mr. Nye, at considerable expense, established a series of fishery stations on the coast of North Carolina in the neighborhood of dreaded Cape Hatteras. The porpoise vary in length from 6 to 12 feet and range from 300 pounds to double that in weight. Having decided to utilize seines for their capture, it was necessary for Mr. Nye to have nets made of exceptional ruggedness. He knew that the nets would have to be strong enough to halt and to hold the creatures when frightened and seeking frantically to escape; and, therefore, he had his nets fashioned of heavy cord with meshes having a spread of eight inches.

The populace at large depends upon porpoise jaw oil to help it keep its appointments, to connect with trains, and otherwise to give due heed to the passing hours. Just how great this dependence is was emphasized a few years back when one of America's biggest makers of clocks was put to no end of trouble and expense because of a bad lubricant. The company had oiled and shipped from its plant something like 250,000 timepieces, and when the retailer and the ultimate purchaser got hold of those clocks the latter refused to run or did so in a way to make it plain that something was radically wrong with them. In the end the whole lot had to be returned to the factory, where each clock was taken apart, cleansed of the gummy oil and then touched here and there with a drop of the duly refined porpoise jaw product.

* Sydney Mornington in *Compressed Air Magazine.*

RANDOM NOTES*

New South Dakota Cave.—A new cave, believed to be even larger [Zoological Society BULLETIN for January, 1914] than either Crystal Cave or Wind Cave in the Black Hills, has been discovered on the ranch of W. H. Dardtt near Black Hawk, and now is being explored and plotted. The cave is located a half-mile west of the Custer battlefield, and Coast to

* From *The Sun* (N. Y.)

Coast highway, six miles northwest of Rapid City.

The entrance, which is through an opening three by five feet, has been cleared out for a distance of thirty feet, and from it five distinct passages or avenues radiate in several directions, leading to numerous large rooms or caves with other passages radiating from them. These chambers are ceiled with crystal formations.

New Federal Bird Refuge.—A new Federal bird reservation, to be known as the Columbia River Bird Refuge, has been created by President Coolidge on two small islands in the Columbia River, at the mouth of the Walla Walla River, Washington, comprising together about eight and a quarter acres of land.

The Biological Survey of the United States Department of Agriculture, under whose jurisdiction the new refuge is placed, has found these rocky islets especially desirable as breeding grounds and safe retreats for wild fowl. From early in winter until the northward migration of wild fowl in the spring the islands have been for years the favorite daytime resting places for hundreds of wild ducks, especially mallards, and wild geese, as well as for gulls, blue herons, and other species in smaller numbers.

The new reservation is not easily accessible to man and already affords waterfowl fairly safe refuge from the fact that the Washington State game law already protects all waterfowl on the Columbia River.

TARPON IS VIVIPAROUS

Dr. C. H. Townsend, while on his way to the Galapagos Islands for the purpose of collecting the giant tortoises found on those islands, sends the following interesting note on the tarpon.

Balboa, Canal Zone.
March 30, 1928.

Dear Mr. Grant:

In conversation with Mr. S. A. Venable of the Zone Police Force, an experienced tarpon fisherman, I was informed that this fish is *viviparous*. He has repeatedly observed the females seeking shallow water, generally less than 4 feet deep, where a continuous stream of young fish was poured from her vent, the young being apparently little more than ¼-inch long. The young immediately seek refuge in groups, under the large scales of the mother, each scale standing outward at an angle of probably 30°. The young clustered in these scale shelters as thickly as they could. Mr. Venable's many observations lead him to believe that the young shelter under the scales ten days or more, when they are ¾-inch long. The mother soon rids herself of the young by shaking herself and by leaping.

I have myself no personal or book knowledge of the tarpon. The above notes may be a record of something entirely new, and may explain the remarkably large scales of this fish. If it isn't new to science, it is to many, including myself.

C. H. Townsend.

THE ROMANCE OF THE BACHAC

By R. R. Mole*

IN the first place what is a parasol ant? It is a species of ant which lives in communities and which systematically raids certain plants for their flowers and leaves. I began to wonder where I could find what the ants did with the flowers and leaves which had been raided and I turned to a good book on Natural History. The raids of the ants were described, and how the ants, with their booty, processioned back to their nest (citadel would be a better word), guarded by their soldiers. But there was not a word of what they did with their spoil. Of course, some one will say, "Why, they ate it of course! That is the last thing the parasol ant would do with its spoil. When one begins to look into the lives of these tiny creatures—ants—one becomes astonished at their diverse complexity. It seems to me that of all the fauna in the world, so far as habits and mode of life are concerned, those which most nearly approach human beings are the ants. It is now well known to naturalists that among ants are to be found certain ones that are hunters, species that are stock keepers, and others again which are agriculturists.

The bachac is essentially an agriculturist, and it lives upon what it grows and upon nothing else. The bachac is a mushroom grower. Man has begun to study mushroom growing only

* In the *Port of Spain Gazette,* Trinidad, B.W.I.



Parasol ants on the march.

in modern times, but the bachac has made a special study of it for probably thousands of years, and moreover grows them and lives upon them. The fact that the bachac is a mushroom grower is the cause of all the trouble of our agriculturists. For bachacs are most industrious and hard working. Ever since I have been in the West Indies the bachac has been a trial to both agriculturists and amateur gardeners. Many thousands of pounds are annually lost to Trinidad and adjacent countries by agriculturists owing to the ravages of these industrious little creatures. Since 1886, and for untold years before that date, the parasol ant has been a never-failing subject of interest and an object of detestation. When I first came here, the only method of destroying them was said to be "puddling." That involved carrying water to the nest, sometimes at great expense, and then converting the site of the nest into a temporary swamp, which was churned by various means until all life had been utterly destroyed. As the nests vary in size from an area which can be covered by an inverted tumbler to a closely associated number which will cover a space of ground of more than twenty yards square, and that frequently the nests are on the side, or the top of a hill, it can be imagined how much water had to be carried. I remember one such nest or group of colonies, that was much larger than that. It was situated on the ridge of the Laventille Hills and far away from any water. A great many dollars would have to be spent before such a stronghold could be permanently annihilated by the use of water.



Soldier and Queen Parasol Ant

To reduce this great expense has been the subject of many years study. The late Mr. J. H. Hart, of the Botanic Gardens, suggested running tar into the holes and entrances to the ants' strongholds, but there were many difficulties and objections to this method. Then some one thought of bi-sulphide of carbon, and as



Parasol ants carrying leaves down the side of a jungle tree.

this proved to be the most effective method of all in destroying parasol ants, it soon became well known, and through its use the parasol ant nuisance is not so dreadful as it was many years ago.



Convolvulus leaves attacked by parasol ants.

While I sympathize with the cultivator and the gardener, who may find their trees and gardens stripped of foliage and the careful work of months undone in a single night, nevertheless the life history of the bachac, or parasol ant, is very wonderful, and well worthy of observation. It is one of the romances of nature.

The common parasol ant is known as *Atta cephalotes,* and there is one other species, which is named *Acromyrmex octospinosus.* But these are not all the fungus growing ants—there are ten other species, but the ten are not offenders for they do not use the leaves of growing plants to grow their crops on.

But we will take the common one: In the evening, in the wet season the young queen of this species, with some of her sisters and a large following of suitors, issues from the parent nest, where they have spent an idle life, fed and groomed by their dwarfed and hard working sisters. When they arrive in the open air they fly up in a dense cloud, enjoying the novel experience of freedom, after the long confinement, ever since birth, in the dark nest. But they soon find out that this new and joyous life is not without its tragedies. They are attacked in force by other insects, and are devoured by birds, and probably by bats, and as they settle on the earth, they are eaten wholesale by frogs and toads, or gobbled up by lizards. The young queen, as she joins in the aerial dance with her many suitors escapes all dangers. The story of that exhilarating courtship with her selected mate in the free air is as wild and romantic as it is brief. Up and up they soar and just when life seems sweetest and most worth living death takes the bridegroom and he falls whirling down to the ground. Then the queen sinks down to earth to escape the many perils of the air, and to take up her burden.

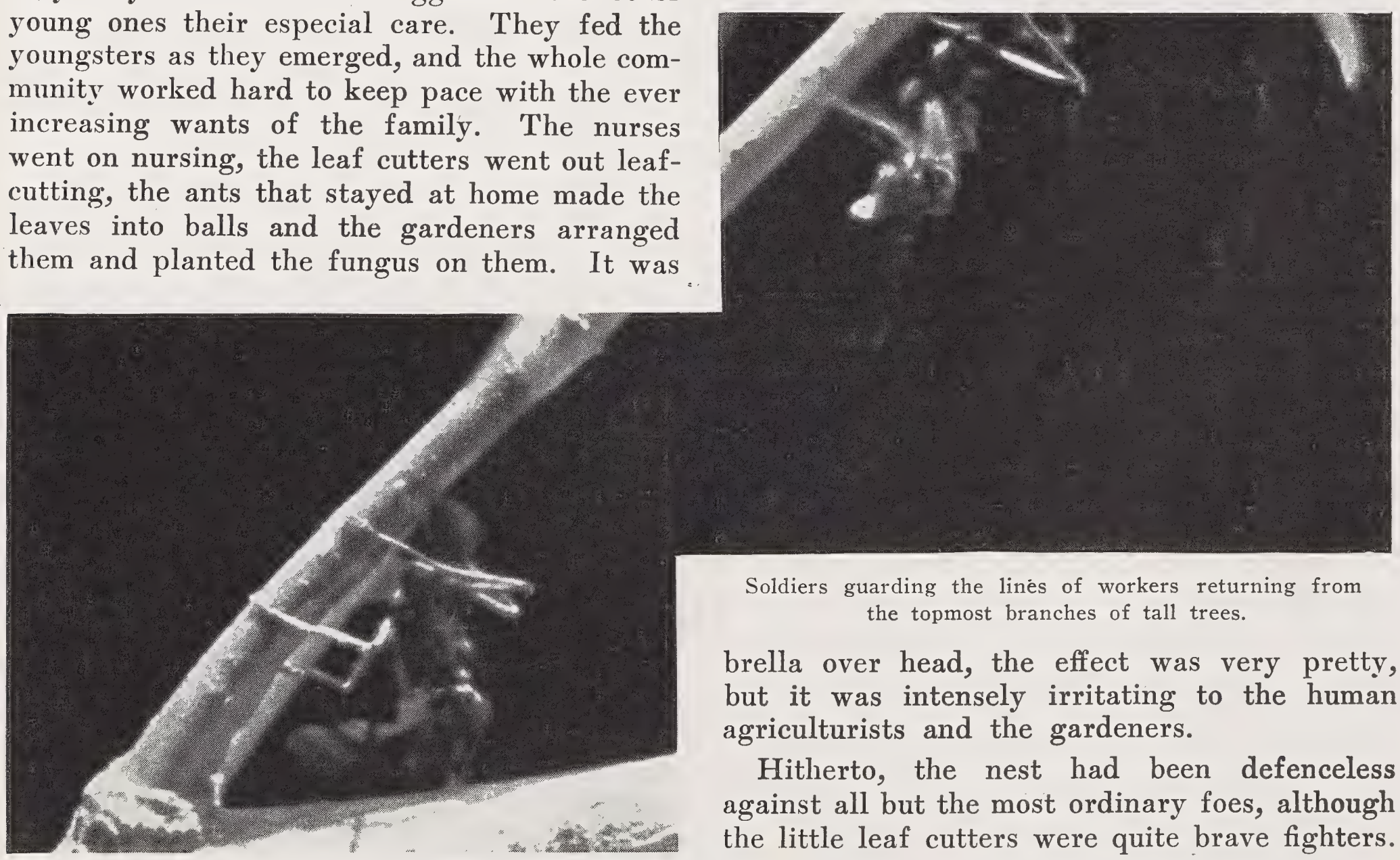
Then, as if in token of her widowhood and her renunciation of the pleasures of flying in the air, she tears off her beautiful long gauzy wings. Selecting a spot, at the root of some plant, or near a stone, a tiny hole is made in the earth in which she conceals herself. Provident, as

the sex is, previously to leaving the home nest, she had furnished herself for eventualities by carrying in the back of her jaws some of the spores of the fungus upon which her people feed. These spores she carefully planted and assiduously attended, and they grew and flourished. Thus she supported herself on the fungus which she grew in her tiny subterranean garden. From time to time she laid eggs and as they hatched she watched the tender little white larvae and carefully fed and washed them. In time they grew—but comparatively speaking, not into great creatures like the queen. They were very tiny things. Some were bigger than others, but they were all very small, and no one would think that the queen and the various sized little ants were all the same species. But, though they were such little mites, and they grew no bigger after they had emerged from the pupa stage, "they started to work." The bigger ones sallied forth day after day, night after night, and sought young cocoa leaves or rose blooms, and the petals of other flowers. These they dexterously cut into a roughly circular shape and carried parasol-like to the nest. The little sisters who had not left the nest took the leaves and worked them up into little balls, and arranged them in orderly fashion in a space which they had prepared underground. Upon these they planted more fungus spores. The very tiny ants made the eggs and the other young ones their especial care. They fed the youngsters as they emerged, and the whole community worked hard to keep pace with the ever increasing wants of the family. The nurses went on nursing, the leaf cutters went out leaf-cutting, the ants that stayed at home made the leaves into balls and the gardeners arranged them and planted the fungus on them. It was



Minute parasol ant stealing a ride home to the nest on a leaf carried by a larger worker.

a growing community, and every day there was an increasing army of leaf-cutters, gardeners, and nurses. The foraging processions became longer and longer, and more numerous, and as the foragers came home, each with a leafy um-



Soldiers guarding the lines of workers returning from the topmost branches of tall trees.

brella over head, the effect was very pretty, but it was intensely irritating to the human agriculturists and the gardeners.

Hitherto, the nest had been defenceless against all but the most ordinary foes, although the little leaf cutters were quite brave fighters.

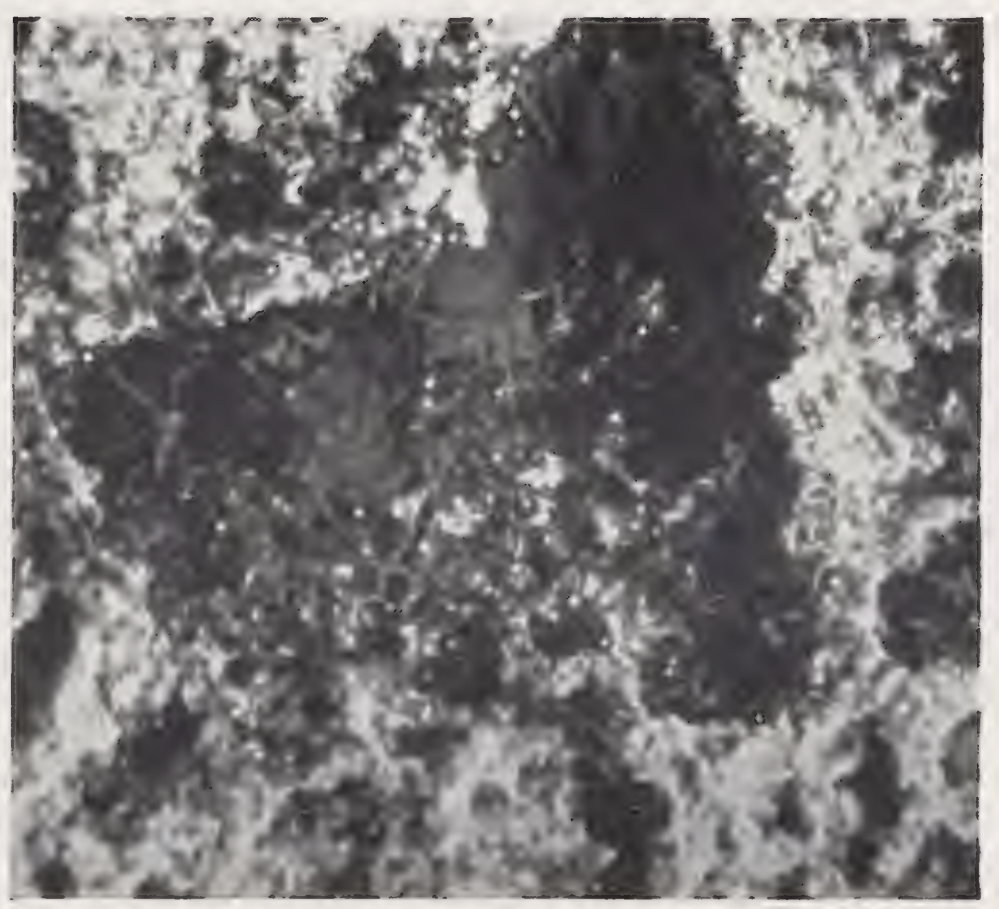




Top,—Dealated queen starting to dig her great nest.
Center,—Parasol ants on their trail.

But they were not strong enough, nor had they sufficiently powerful mandibles to make much impression on any but the most ordinary enemies of the community. There was much more food now, and so the busy nurses began to make preparations for raising and maintaining an army. Rations were increased to some of their charges, and these consequently developed into very much larger insects,—soldier ants with big heads, and large and powerful jaws. Thus a standing army was created. None of the ants in the community can see very well, and the soldiers have the weakest vision of all. Perhaps that is the reason they are so brave, for like the blindfolded gladiators of the Roman arena, when danger threatens they rush to the spot, bury their huge scissor-scythe-like mandibles in the enemy and rather than let go, allow their bodies to be torn from their heads. At this time the nest is composed of nurses of various sizes, gardeners, leaf-cutters, and soldiers. All of them are aborted females—the only perfect ant in the nest is the queen mother.

When the nurses aspire to develop something greater and more perfect, they increase the food supply of some of the larvae and by other arts of which we know nothing at present, they produce a few perfect females, prospective queens, and a great many perfect males. These new tenants of the nest greatly increase the expenditure, they do no work and only eat. They live an idle life possibly until the swarming instinct takes possession of the perfect insects, and then, when some suitable evening comes, there is another great exodus from the nest and the brief history here sketched is repeated all over again. In large and well established nests there are as



The queen in the center of a fungus garden attended by her numerous offspring.

many as fifteen sizes of parasol ants besides the perfect males and prospective queens, and all have their special duties to perform.

The late Mr. J. H. Hart, the Curator for many years of the Botanic Gardens, in an article on these ants, said that he had several times tried to maintain a nest artificially without any real margin of success, to observe the development of the fungus on which the insects were said to feed. Bates, the traveller, had said they used the leaves to thatch the domes which cover the entrances to their underground nests. Belt, another traveller, said they used the leaves to grow the fungus on which they fed. Both theories have been proved correct.

Mr. Hart endeavored to classify the fungus and submitted his decision to Kew, where it was pronounced to be what Mr. Hart thought it to be—a Phycomycetes. Mr. Hart's No. 1 and No. 2 nest were taken on the same day and No. 3 nearly a month later. Neither nest having a queen, he got one from another nest which was about to be destroyed. The queen, he says, is easily recognized by the presence of three ocelli, triangularly disposed in the center of the front of the head. The queen was well received and attended by a numerous retinue. On August 30, he removed the queen from No. 1 and placed her in No. 2, where she was also loyally received. Ants taken from Nos. 1 and 2 and placed in No. 3 were destroyed by the latter. The soldiers, workers and nurses of No. 3 were destroyed when placed in Nos. 1 and 2. Nests Nos. 1 and 2 fed greedily on almost any kind of food presented. That, I may interpolate, seems extraordinary, as all the Parasol Ants, so far as I know, live on their own grown fungus. No. 2, Mr. Hart says, did not carry







Wounded and dead parasol ant soldiers after a battle with army ants.



Upper,—The worker grasps the edge of the leaf with his feet, and scissors out a section with his mandibles, pivoting on his hind legs so that the resulting cut is semicircular. *Center,*—Carrying the leaves home along a sandy trail.

well to the nest. No. 3 did not carry into the nest but made a high heap outside the entrance and afterwards transported it inside. In No. 1, a new queen and males were being developed. In No. 2, where the queen was kept only workers were being brought out. A small ant guest appeared about six weeks after the nests were established, but only in Nos. 2 and 3. Mr. Hart attributed its appearance to the humidity maintained in the nest. In No. 1, which was kept dry, it did not appear.

Mr. Hart decided that in his opinion, a small number of worker ants could found a colony, if they have a portion of an old nest, but he had not observed the fungus to occur spontaneously. The workers themselves were able to produce queens or males, without the immediate aid of a queen or male. The parasol ant has no sting and only grips with its mandibles. The soldier ant can draw blood. The parasol ant is easily destroyed by small foraging ants which seem to be its natural enemy. The parasol ant passes through the following stages: (1) egg; (2) larvae, when it cannot feed itself; (3) pupa; (4) perfect insect. To pass through all stages from egg to mature worker takes about 57 days. Queens and males develop more slowly over a longer interval. If the living insects are destroyed in a nest, the eggs canont produce a new colony. A new colony seeking a home will seize on an old nest, if any quantity of fungoid material is left. The food of the larvae is the fruit of the fungus. A portion taken from the mouth of a larvae after it had been placed there by a nurse was identified under the microscope. The ants lick with their tongues, and so appear to sterilize the leaf licked in such a manner, that no fungus spores grow other than the required food.



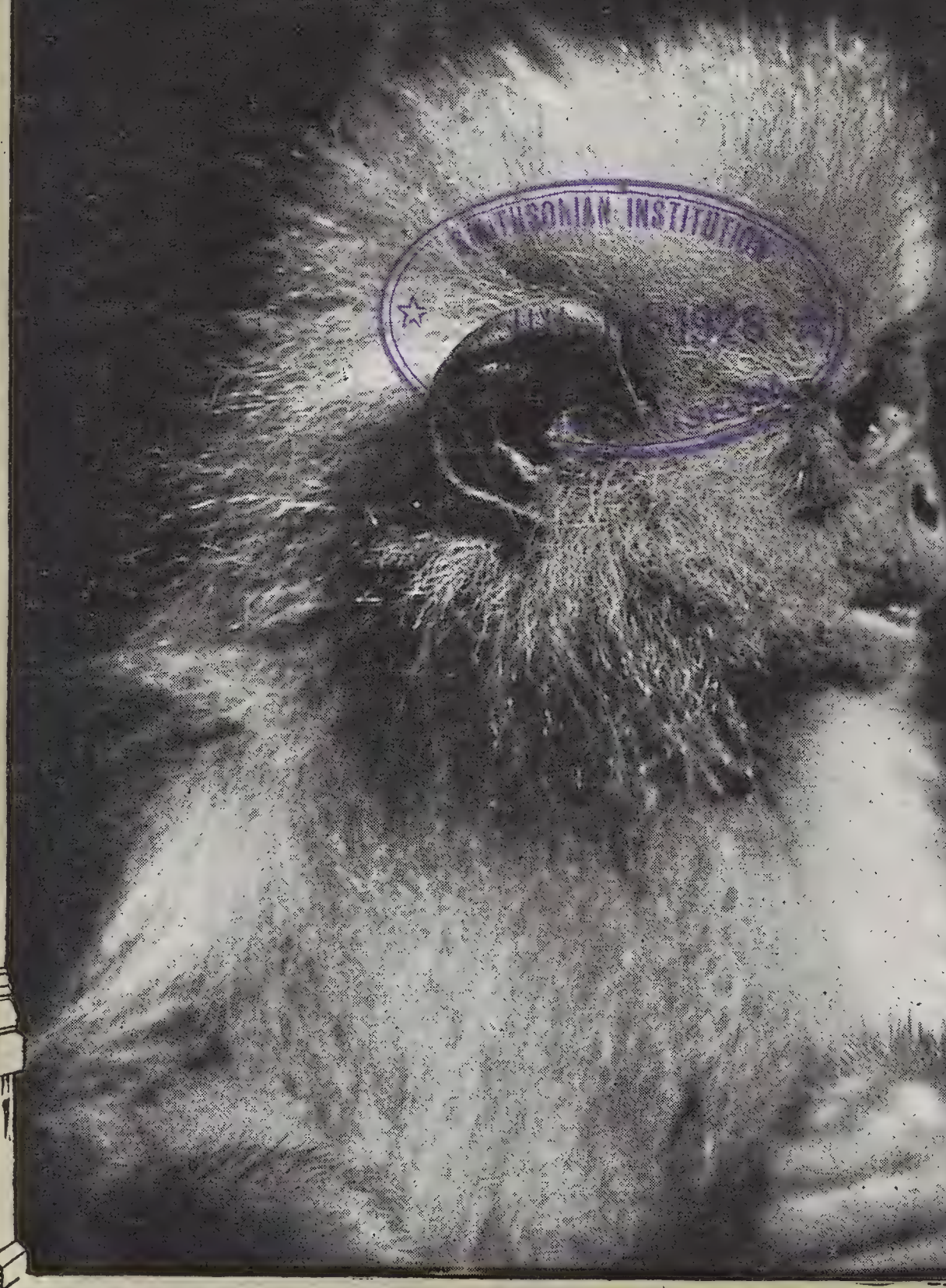
When investigating the nests of the leaf cutters, it is necessary to wear fluffy cotton below one's knees, which entangles the feet of the ants. The soldiers are capable of inflicting a severe bite.

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THE MONKEY LEGION[1]

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IN a discussion of monkeys, the term and its standing should be clearly understood. Monkeys are members of the most important order of mammals, the Primates, containing two suborders, the Anthropoidea and Lemuroidea. The former is led by the three highest families in mammalian classification —that of man, the larger anthropoid apes and the gibbons.[2] The monkeys complete the order with two extensive families and one smaller one. All Old World monkeys and their allies, the baboons, belong to a single family. The two New World families show the lesser variety of structure among the species.

To the reader but casually interested in monkeys, a simple procession of facts may offer a number of surprises. The object of this article is to briefly review the whole group—in the sympathetic manner of one particularly interested in the living animals, without a large use of technical names.

In indicating the imposing array of the monkeys (and baboons) it should be noted that approximately five hundred species are recognized, these being divided into more than thirty genera. The species are distributed throughout the American tropics, while in the Old World, where there is a far greater number, they range farther north and south of the Equator, a few even living in latitudes of winter snows. Africa might be called the great headquarters, for here are the extensive groups of the Guenons, with eighty-five species and subspecies; the Guerezas, with twenty-nine species; and the Mangabeys, with eleven species. The Indo-Malayan region also has an extensive variety of species, including the characteristic Macaques of over fifty species. Some monkeys are of wide distribution, while others appear to be confined to areas of moderate size. A few occur only on groups of islands.

THE OLD WORLD MONKEYS

About three-quarters of the total number of monkey species inhabit the Old World. Structurally and mentally they rank higher than the species of America. Despite their variety of form, all are included within the family *Lasiopygidae* (*Cercopithecidae*).[3] This is a family of contrasts. Some of the species are small and attractive in form, with delicate body hues, and are gentle or actually affectionate, while the giant baboons are exceedingly powerful and have enormous canine teeth. They are dangerous antagonists in close quarters, and the faces of some are marked with colors or livid patches as sinister as an idol. Most of the members of this family inhabit the hot or semi-tropical areas, some living in humid forests, others in quite sterile areas, while a few have extended their

[1] The illustrations accompanying this article are from photographs by the Author and the collections of the Society. Those made by the Author are enlargements from motion picture film and are designated by his initials.

[2] From the former inclusion of the chimpanzee, gorilla, orang-utan and gibbons in a single family of anthropoid apes, Elliot now separates the latter in a distinct family—the *Hylobatidae*.

[3] The technical nomenclature of Elliot's monumental work "A Review of the Primates" is generally followed, but to avoid confusion in the use of generic names and a few specific ones, which have changed over those of long standing, the writer has included the latter in parenthesis.

habitat into temperate climes. Monkeys are found among the lower ranges of the Himalayas and in the short winters may be seen playing among the branches of snow-laden trees. Two species are unique in being found in the elevated regions of eastern Tibet, and are able to endure really severe cold.

It may be surprising to many readers to learn that in this great family of the Old World there is a complete absence of prehensile tails—so commonly associated with ideas of monkeys. This useful appendage is found only among New World species. The greater number of Old World monkeys are persistently arboreal and many have extremely long and decorative tails, but the adjective altogether defines the value of the appendage. Their hands are generally more adept than those of American species, the greater number having thumbs opposable to the fingers—a condition but slightly indicated among American races.

After eliminating such a legendary character as the prehensile tail from the entire group of Old World monkeys, it is but just to provide them with uniquely simian points of equal importance which are entirely their own. One of these is the pair of elastic cheek pouches for the temporary storage of food and adding much to their vivacity and drollery —although these pouches are absent among a few Indian and African genera. Another character enjoyed exclusively by the Old World monkeys is the presence of patches of hard, naked skin on the buttocks. These are known as callosities. All of the species possess them to some extent. With some they are unobtrusive and blend with the body hue, while with others they are very prominently developed and unpleasantly bold in coloration. Simply speaking, these callosities are no more or less than cushions to afford a comfortable rest when the animal is in a sitting position. The dignity of some of the larger species, which are more luxuriantly provided, greatly suffers from this development.

Another point favoring the Old World monkeys is size. By far the largest members among the three families exist among the *Lasiopygidae*. These are the baboons, which far eclipse in size the big Howlers of tropical America. Another point for the Old World family is their greater adaptability to life on the ground. Most of the species can run with great speed and many can swim with great facility. Contrary to general supposition, a number of Old World monkeys are fond of the water, particularly the macaques, and are strong swimmers.

Three rather unique and closely allied genera inhabit Asia and Africa. The species are large and very lanky and have excessively long tails. They lack the characteristic cheek pouches of the greater number of Old World monkeys. Curiously enough, the stomach of these monkeys is divided into a number of sacs or pouches. Not only do they thus differ anatomically from other monkeys, but their general habits are at variance. They might be said to possess a certain dignity, a marked lack of facial mobility, as compared to monkeys generally. We have found them to be silent types in captivity, very delicate, and have sought to discourage animal dealers from importing them. The Langurs, of the Asiatic genus *Pygathrix* (*Semnopithecus*), forming part of this group of fifty species, are handsome monkeys. The Entellus or Hanuman monkey is typical. A large specimen will sit as high as thirty inches and the color ranges from gray to nearly pure white, with a black and impressive, though wistful and immobile face. The writer believes that these monkeys are largely leaf eaters and can be successfully studied in captivity if arrangements are made to flood their quarters with sunshine and very carefully regulate the diet, as we have successfully done with the allegedly delicate Howling Monkey of Brazil. The very curious Proboscis Monkey is closely allied, but so far as we know, has never been successfully exhibited.

Unfortunately for the members of a related African genus, *Colobus*, the members have attained prominence by a sad turning of fashion to "monkey fur." The Colobs or Guerezas are large and very handsome monkeys, clad in flowing and lustrous silky hair, which on the sides of several species falls in a graceful fringe. The general markings are intense black and white. It was for this fringe of hair that an appalling slaughter took place among these attractive creatures and which appears to continue. All the members are

quite thumbless, rendering them unique among African monkeys. A superb specimen was on exhibition for a number of years in our Primate House. It was very affectionate, though a silent creature, in strong contrast to the vociferous members of other groups on all sides. The various species are rated as delicate in captivity.

It has been previously mentioned that Africa is the great headquarters, and here we encounter the imposing genus *Lasiopyga*[4] (*Cercopithecus*) with eighty species and subspecies, the largest group among all the monkeys. The majority are found on the western side of the continent. All have cheek pouches and well developed hands. There is a monotony of form among these species. The body is rather slender and the tail uniformly long, but coloration is inclined to run riot. Some have greenish hair, others are red, and some almost black. The breasts and arms of some are snowy white. Dark species have snow-white beards. With the gorgeous Diana Monkey, named for the white crescent on the forehead, the breast is pure white, while the back, in strong contrast, is blackish, with a central band of red, and a similar bold hue covering each thigh. The Mona Monkey is distinguished by a violet colored face and fleshy-hued lips. *Lasiopyga cephus,* a small West African species now on exhibition, has a white nose, while the lips are broadly marked with vivid blue, like the face of a clown. Several small species with black faces have a snow-white nose, as if dipped in a flour barrel. Most of the species are hardy, and savage when adult. The males grow long and sharp canine teeth, and when threatening an intruder, pretend to yawn and thus display these weapons.

Mobility of face points to a possibility of psychological research with monkeys. It appears that here exists a certain definite method of expression. The Mangabeys (*Cercocebus*), a small group of quite large West African monkeys, offer interesting examples for study along these lines. Different groups of monkeys indicate various methods of facial expression. These may not be clearly apparent on gross examination, but present possibilities of definite separation if critically observed. The Mangabeys have blackish faces, and in strong contrast are the vivid white eyelids. That these eyelids are so marked for a definite purpose seems clear, when we note the common trait among these monkeys of what animal men call "flirting." The eyebrows may be quickly elevated until the white lids are in instant and vivid contrast—a character to be noted at a considerable distance.

Young Mangabeys are easily tamed, but quickly become dangerous owing to the common monkey habit of "championing" the owner and attacking anyone who attempts to shake hands or is regarded with doubt by the suspicious animal.

Ranging throughout the Indo-Malayan region, northward into China and Japan, even into eastern Tibet, is the important group of *Pithecus*. There are more than fifty species. These are characteristic monkeys, rather unlike the members of any other group. Upon this group hinges an argument as to the importance of lengths of tails. No other genus of monkeys shows such variety in length or proportionate thickness of the caudal appendage. Bodily, the Macaques are uniformly stout, with proportionately large head. They may be rated as the most hardy of all monkeys.

The tails range from a long, sweeping appendage, tufted at the tip, with the Lion Macaque or Wanderoo, to a strong looking member about the length of the body with the common "Java" Monkey, *P. irus* (*cynomolgus*) which actually inhabits Burma and the Malay Peninsula. The powerful Rhesus Monkey, *P. rhesus,* of India, has a thick and stubby tail, appearing much like that of a docked dog, while the Pig-tailed Monkey, *P. nemestrinus,* of Malaysia, has a thin and ludicrously curled appendage. *P. fuscatus,* a large and powerful species of Japan, with fiery red face, has a mere vestige of a tail, while the Barbary "Ape," *Simia sylvanus* (*inuus*)[5] is quite destitute of appendage.

Distribution of the Macques is the most interesting of any group of monkeys. The Barbary "Ape" is thrown far to the westward

[4] By some authorities the species are split into several genera.

[5] Recently accorded generic distinction in the Macaque group owing to external absence of tail.

and away from contact with the other members. It inhabits the northerly coast of Africa, through Algeria and Morocco, and is the only African member. This is the famous "Ape" of Gibraltar, but visitors to that interesting spot should not expect to see monkeys sporting generally over the bare, mountainous rock. The military commandant at Gibraltar the past summer told the writer that he doubted if there were more than twenty specimens in the whole area. They appear here and there, according to the direction of the winds, and as they range over a couple of miles of territory, the chance of seeing them during a short visit is remote. It is doubtful if two in a hundred of the tourists who briefly stop at this port to buy souvenirs have ever seen members of the monkey colony. The writer has spent several days at Gibraltar, during two separate trips, has scanned various portions of the rock and its adjacent slopes, with powerful glasses, been well up the ridges and has never seen one of the "Apes"—so called from the lack of tail. This is the only monkey on European soil, but it is doubtful if the distribution is natural. It seems more probable that specimens were introduced by the Moors in their numerous Spanish conquests. Not far back from the port of Algiers there is a colony of Barbary "Apes," which are tame enough to be visited and numerous tourists go out to see them. Some of the male monkeys of the colony are of great size and strength, and it is told that several tourists have been attacked and severely bitten.

Going back to the Indo-Malayan region, the Macaque headquarters, we find a number of species and from here they radiate in interesting fashion. The large and powerful Rhesus Monkey and several allied species extend their range into the cold winters of China, but more remarkable is the hardihood of two big species, *P. thibetanum* and *P. vestitus,* which range into Tibet. They are burly, savage brutes, heavily haired to endure the actual blizzards of their home country. The big Japanese Macaque is of similar physique. These species are active and savage as captives when adult, not really morose, but ready to fight at a snap of the finger. They do better if given access to out of doors all winter, and have records of living considerably over twenty years. In size they are possibly ranked by the Burmese Pig-tailed Monkey and the Black Macaques of the Celebes. The latter are remarkable in showing parallel development with an equally large but unrelated species called the Celebes Black "Ape" *Cynopithecus niger.* So remarkable is the similarity of these two creatures confined to Celebes and the nearby smaller islands that animal dealers frequently confuse them. We have three specimens at the present time which were shipped us with the understanding that they were Black "Apes." What influence produced this parallelism is problematical, but Black Macaques have departed from the normal olive or tan hue of the group, developed a long, thin nose, which with the vestigial tail produces almost the counterpart of *Cynopithecus,* with its single species. The Celebes Macaques have more recently been accorded distinct generic recognition.[6]

Macaques are typical monkeys as regards favorite legendary characteristics applied to the race. They have enormous cheek pouches, and are much given to facial grimaces and motions of the lips. They are extremely vociferous in chattering, uttering crooning sounds, shrill calls, grunts, barks and ear-splitting sounds approaching yells, which appear to give them much relief in moments of rage. They are not inclined to seriously fighting among themselves, though feeding time may produce pandemonium and a frenzied storing in cheek pouches, with no hint of courtesy to companions, youth or females. Young specimens are docile and affectionate, and make amusing pets—on a ranch or place of the kind. No animal can be more mischievous or destructive in living quarters, where there is anything to break. As they grow older they develop an unpleasant tendency to protect the owner against imaginary harm and will treacherously attack visitors. The writer has long gone on record in warning against the danger of maintaining pet monkeys unless with a full knowledge of their habits.

[6] *Magus.*

By far the largest and most spectacular members of the monkey families come within a group known as the Baboons. There is not much structural difference between them and the larger monkeys, but baboons have an elongated or dog-like head, and appear fairly characteristic. There are nineteen species and two genera, the greater number of species falling within the genus *Papio*. All are African, with a slight extension into Arabia.

Several of the baboons are the most forbidding in appearance of all mammals, having livid facial hues or grotesque patches like hideous clowns. Adult males are provided with enormously developed canine teeth, as sharp as daggers, which are frequently flashed at intruders by simulated yawns. Powerful in body, naturally audacious and backed with the assurance of moving in numbers, these creatures may be rated as well to avoid.

It is fortunate for general animal life that their tendency to develop size and massive frame stopped where it did. If they had reached the size of the anthropoid apes, they would be among the most frightful creatures the earth has ever known.

Like many young mammals, the immature baboon is quite playful and gentle, and frequently affectionate. With most of them this demeanor rapidly changes in nearing the adult stage and insolence takes its place, usually giving way to treacherous savagery. The demeanor of the average adult baboon hints at a combination of bestial cunning that is curiously repellent, quite different from the admiration we feel for a purely antagonistic type like a savage leopard or tiger. Mentally, at least, the baboons appear to differ from the monkeys in this respect and indicate a psychological if not a structural gap between them. They are particularly hardy as captives.

Like the monkeys, baboons walk upon the flat of the foot and flat hand directed forward. Being far more terrestrial than the monkeys and accustomed to turning over many stones in search of food, their hands are stronger and more adept than most monkeys. This has been clearly illustrated with several baboons of different species on exhibition in the Park, which have developed habits of throwing missiles when in a rage.

It is not uncommon for an angry monkey of the Old World to hurl a pan in the *direction* of its anger, but the cast is erratic and the gesture little more than demonstrative. There is no accuracy of aim, or intention of actual accuracy. It has been very positively stated that none among the lower primates can accurately hurl a missile or will attempt to use a weapon. The writer has never observed a savage monkey or baboon attempt to use a stick or club in offensive or defensive tactics, nor has he ever noted any among the lower primates accurately cast a missile, with the exception of baboons. With one specimen this was discovered quite accidentally. Having noted a disturbance among the visitors outside the Primate House, we investigated a row of cages where several large and savage baboons were quartered. One of these animals had loosened a panel of cement sheathing, which had fallen upon the stone floor and broken into sharp pieces. These were being hurled at visitors through the bars, in deliberate fashion and with excellent aim. The crowd had retreated to form a large semicircle and the fragments flew straight and hard, and with enough force to produce serious injury. Keeper Palmer and the writer afterwards made a number of experiments with this big Yellow Baboon, *Papio cynocephalus*. We tried him with a shovelfull of coal and ran to different points to see if he deliberately aimed at us. This he did, with dangerous accuracy. The method of casting the missile was curious, directly outward from the side of the body, an overhand throw with the palm turned inward, and opposite to the direction of the toss. The long hand and wrist appeared to snap into the movement in adding impetus to the missile as it left the fingers.

A large Chacma Baboon, *P. porcarius*, reacted similarly during these experiments. It is particularly interesting to note that both of these animals reacted without previous attempts or practice—the Yellow Baboon finding itself provided with missiles, upon breaking of the cement panel, and the Chacma, on being suddenly provided with missiles by the ex-

perimenters. From this it would seem that the practice is not uncommon among Baboons.

As with the Macaques, there is a great diversity of tails with the main genus—*Papio*. The Mandrill, *P. sphinx*, of West Africa, is hideously ugly, with red nose and swollen cheeks of vivid blue. It has a mere vestige of tail, as does the Drill, *P. leucophaeus*, of even larger size, but less like an alarming nightmare in coloration. The Hamadryas Baboon, *P. hamadryas*, with its flowing mane, like a lion, and long, tufted tail, is in strong contrast. The Chacma, of southern Africa, the Olive Baboon, *P. ibeanus*, of East Africa, the West African Baboon, *P. nigeriae*, and the Abyssinian Baboon, *P. doguera*, are giants of the genus. The remaining Baboon genus, Theropithecus, contains two species, both Geladas. No more forbidding creature than an adult of these species can be imagined. They are extremely vivacious in facial expression, from flashing of white eyelids on black face, to turning the lips wrong-side out, well upward, and downward over the chin, the actions accompanied by maniacal moans and cacklings, exaggerated yawns and protrusion of enormous canines. A great flowing cape of lusterless hair falls over the shoulders. A dwarfed caricature of a lion or some legendary thing gone mad, best describes this strange beast, with its great naked crescent of red upon the breast. It represents the ultimate in Baboons.

The New World Monkeys

Most of the New World monkeys have prehensile tails, a development not existing among Old World species. This is all the more interesting, as the prehensile tails of different genera are developed to an extreme degree of perfection as a grasping organ, being of equal value of a limb, and even bare beneath, upon the terminal quarter, to prevent slipping, the skin texture curiously like the inside of a finger.

Here is a problem of marked differentiation from Old World monkeys, too heavy to be discussed in detail here, except to mention that it warrants conjecture as to whether American monkeys have longer been influenced by forests of lofty heights. Certain it is that they are more secure in progressing through the trees, and persisting in such an environment, their hands have differed. This may be seen in the photograph of the adult Howling Monkey, grasping a portion of banana. The fingers are extremely long and the thumb not opposable. Hence the grasp of a small, detached object is accomplished by practically winding the long hand about it, the thumb having little to do with the grasp. While this is an excellent hand for arboreal locomotion—pointing, in fact, to a strictly arboreal life—it lacks the character and fine development of the hand of average Old World species, with which the thumb is opposable to the fingers. And not only is the crude thumb of the fourteen species of howlers an indication of this general difference in hands. The Spider Monkeys, forming an equally large genus, are thumbless, the hand being extremely slender, extending straight to the wrist in outline from its scanty breadth across the excessively elongated four fingers. Character of the thumb appears to vary upon the degree of prehensile dexterity possessed by the owner's tail.

Another marked and unvarying difference of the New World monkeys is the absence of cheek pouches for the temporary storage of food, which adds enormously to simian character. This drollery, eliminated from the American species, combined with lack of facial grimace common to Old World monkeys, produces a generally less vivacious group—and to many students a less interesting one.

Expressive gestures are limited to nodding of the head or the tilting of the head to one side then to the other—so commonly noted with Sapajous—to the slight extension of the lips of Woolly Monkeys and the Spiders. Expressive sounds are plaintive, with some species almost bird-like. The Sapajous scream loudly when angry. Species of *Alouatta*, the Howlers, produce deep roars. These are the largest American monkeys, some of the specimens being two feet high in a sitting position. They are massive and savage when fully grown, while the young appear strong and agile. Yet they are among the most delicate of all captive animals. Up to within a few years ago, no zoological institution had man-

aged to exhibit a specimen longer than approximately a year, and the greater number had died within a few months.

A specific diet and plenty of sunshine for the greater part of the day are absolutely necessary to keep a Howler alive in captivity. The diet consists mainly of leaves, of which the oak and wistaria appear to be favorites. An astonishing amount of leaves is consumed by our Red Howler at a single meal, and in addition a moderate amount of mixed fruit and meat. Specimens appear to need the latter. If removed from the sun, they eat but sparingly, and soon fail. They require high temperature and do not understand cold. When chilled, they appear to be convinced they are ill, and will not eat. Our large specimen at the Park will eat but little or not at all on a cloudy day in winter.

Head Keeper Toomey now holds the world's record in having a specimen on exhibition over three years' time. This monkey was reared from an infant, and is now full grown. It is mahogany brown in color, and his roar is deep-throated and as loud as that of a large feline.

The Spider and Woolly Monkeys, closely related to the Howlers, are hardy, and eat a variety of foods. They do not require any such specific diet as leaves, and are not susceptible to moderate changes of temperature. The Woolly Monkey is rather characteristic in being extremely docile, this even being the case with the fully-grown males, with which the canine teeth are greatly developed. Among many specimens, the writer cannot remember a single example that could not be freely handled or which showed an inclination to escape.

Cebus is the most extensive genus in the American tropics. It contains the familiar Sapajous, to the number of twenty-four species. They are sometimes called Ring-tails, owing to the terminal portion of the prehensile tail often being carried tightly coiled. The tail is not so strongly prehensile as with the Howlers, Spiders or Woolly Monkeys, nor is it bare upon the under surface. These are the most hardy of American monkeys, live for years in captivity, and suffer principally from lack of sun, which results in a condition similar to rickets and improperly called "cage" paralysis. They are the types so frequently seen traveling with the itinerant organ grinder, and while not living under happy conditions, are usually in fine health and vigor, owing to exercise, light and air.

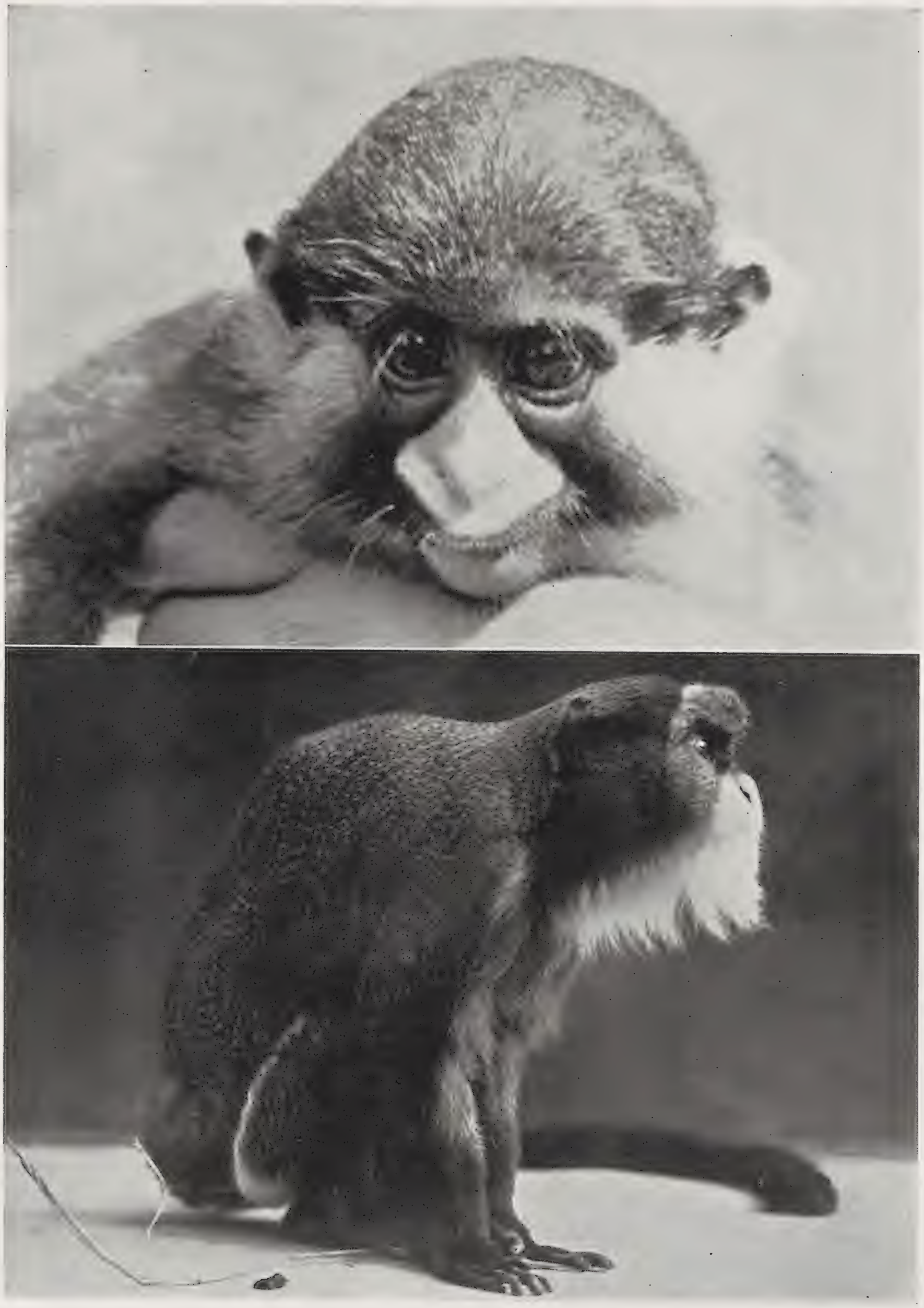
As a certain monotony attends a procession of American monkey genera, it is well to briefly group a few, in closing. The Sakis, *Pithecia,* are a curious group of eight species, luxuriantly clad in flowing, woolly hair, which falls from the head and over the shoulders like apparel designed for extreme cold. All of the species have extremely long, bushy tails, which are not prehensile. The rather closely related Squirrel Monkeys are beautiful creatures, and when in the trees might readily be mistaken for a squirrel in size and action, except for the long, slender tail. The soft and silky body coat is of pale greenish-gold, so like a coat of delicate moss in texture and hue, that this small genus of eight species is sometimes designated as the Moss Monkeys. The long tail is not prehensile, nor is that of the Owl Monkeys. The latter group of fifteen species, is unique in being nocturnal.

Ranging in body size from a chipmunk to a large fox squirrel, is a distinct and unique family of miniature monkeys, the *Callitrichidae* (*Hapalidae*). These are the Marmosets, Tamarins and Titis. This, and the family *Cebidae,* of species enumerated in former paragraphs, contain all the New World monkeys. The Marmosets and their tiny allies, form a zoological explosion of oddities in color and decorative pelage. There are over sixty species, divided into six genera. Some of these elf-like creatures, with expressive faces not much larger than a marble, are extremely pretty, with lustrous, silky black, red, or pale gray pelage, a few with snow white arms and legs, several with a tuft of white, like a ball of cotton, on the top of the head, or tufted ears. One species, the largest, is covered with flowing golden hair. It appears as if swathed in gleaming yellow silk of the finest texture. All are largely insectivorous and as captives require the most painstaking care. Their cries are strangely like the sounds of birds.



Vervet Monkey, *Lasiopyga pygerythra.* East Africa. The long and handsome tail, thickly and smoothly covered with hair and terminating in a black tuft is characteristic of the monkeys of this genus. The appendage is largely decorative, however, as it lacks prehensile power—as do the tails of Old World monkeys. It seems remarkable to note that prehensile tails among monkeys are restricted to the New World species.

(Lower) The Vervet Monkey is one of the larger species of the most extensive African genus. Its hair is greenish gray. The skin of hands and face is black, but that of portions of the body is vivid blue. These monkeys are fleet on the ground, and equally at home in the trees. *Photograph by R. L. Ditmars.*



Moustache Monkey, *Lasiopyga cephus.* West Africa. A small member of the extensive genus of Guenons, which contains eighty-five species and subspecies. A number have brightly colored pelage and a few are quaintly decorated by facial markings. This species has a white nose and vivid blue moustache, the marking being of paint-like effect, similar to the face of a clown. *Photograph by R. L. Ditmars.*

(Lower) De Brazza Monkey *Lasiopyga brazzae.* West Africa. Named in honor of the Count de Brazza. This species appears to be rare and is seldom exhibited. The monkeys of this group are inclined to be savage when adult and lack the friendly interest exhibited by other Old World species.

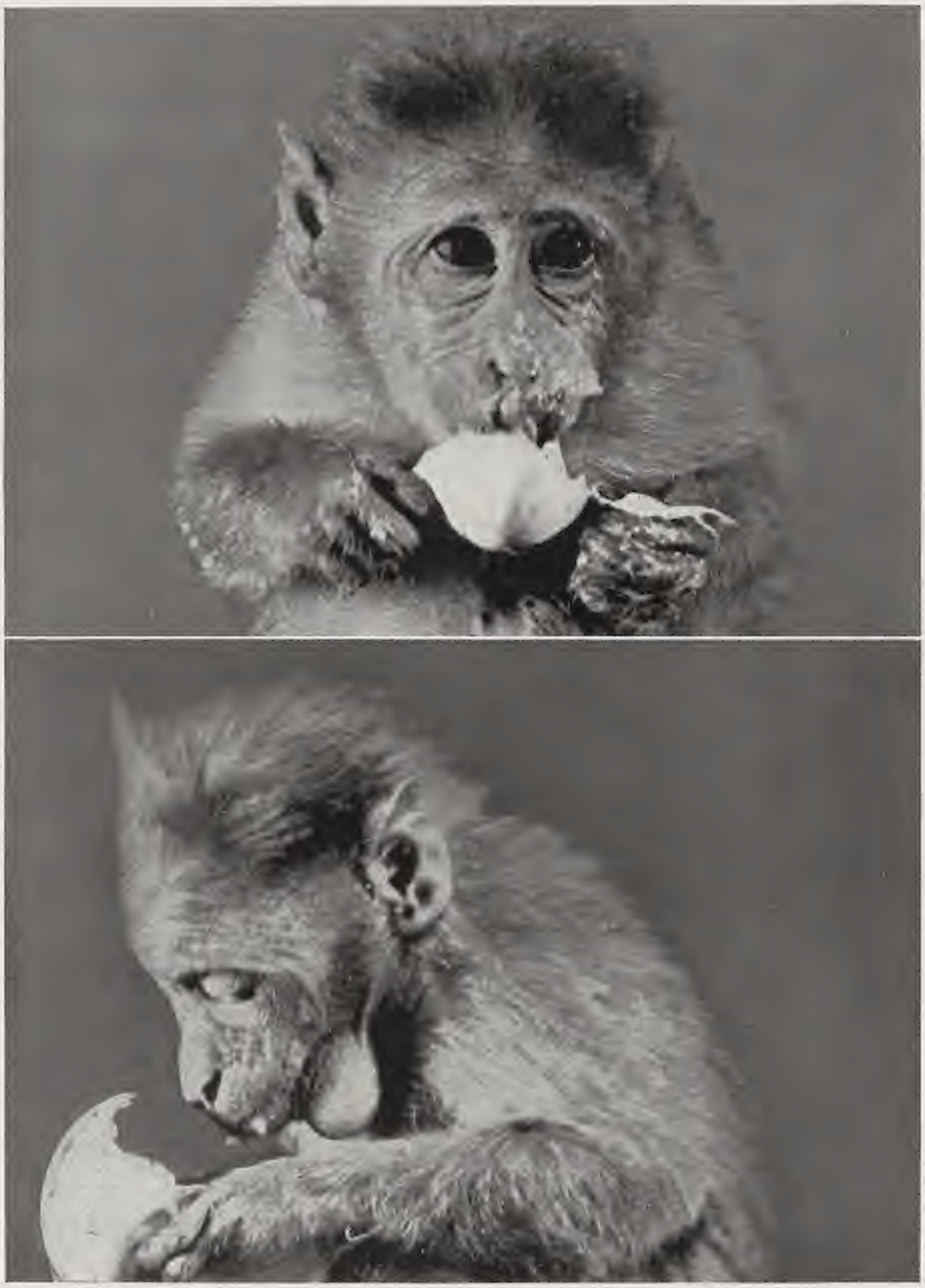


Spot-Nosed Monkey, *Lasiopyga petaurista.* West Africa. Facial decoration is common among the members of this large and ornate genus. A group of the smaller species having a white spot on the nose. They are specifically separated by their white side-whiskers. *Photograph by E. R. Osterndorff.*

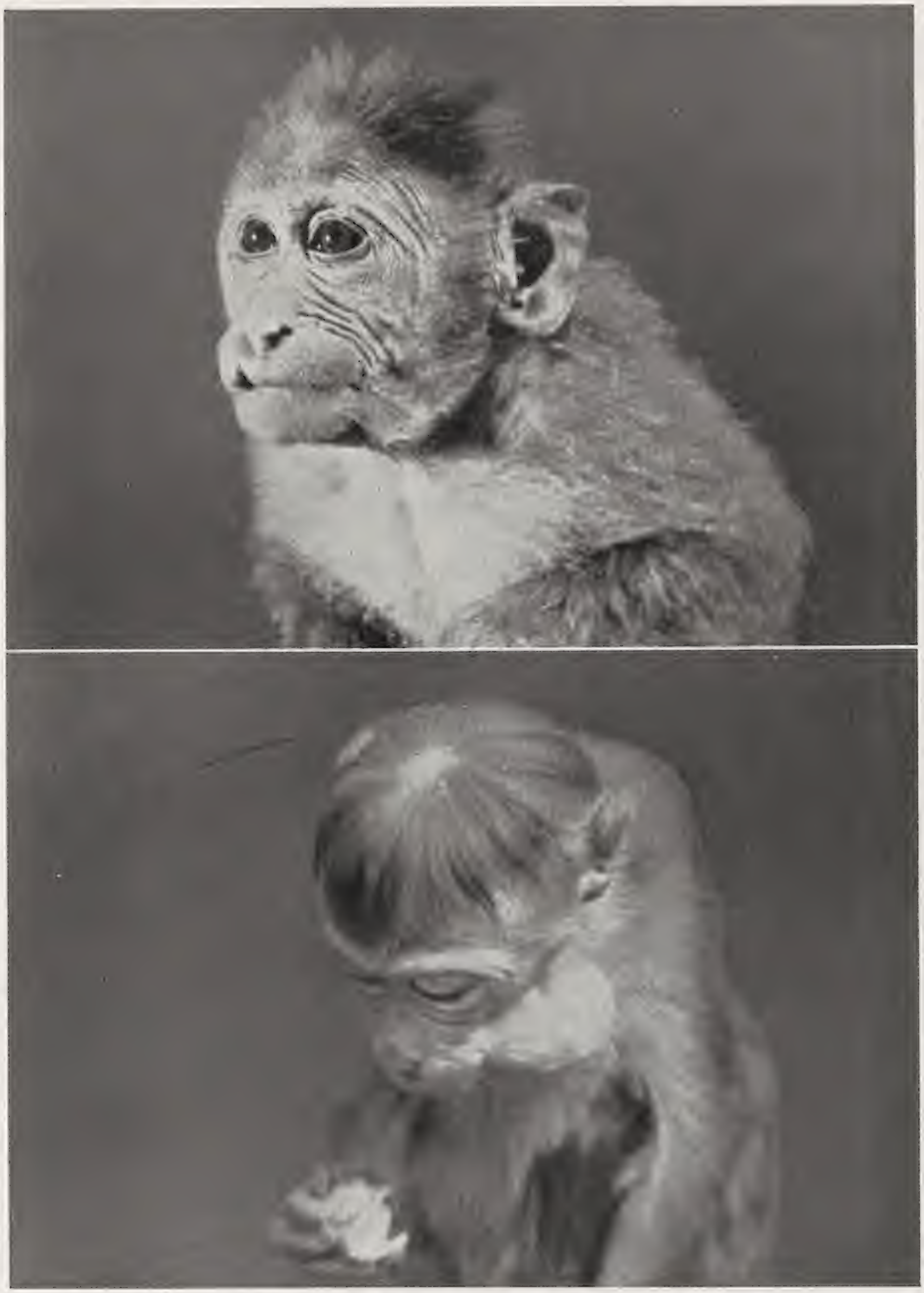
(Lower) Hanuman Monkey, *Pygathrix entellus.* India. This large, slender and rather pensive-looking species represents the extensive genus of Langurs, of which there are more than fifty species, all of them Indian and Malayan. Together with the Guerezas of Africa, they are characteristic among Old World monkeys in lacking elastic cheek pouches. They are shy, and delicate as captives.



Red-Headed Mangabey, *Cerococebus torquatus,* West Africa. Mangabeys form quite a large genus of strong, uniformly long-tailed species, the majority of dull, grayish body hues. A few are brightly marked about the head and face. The top of the head of this species is of rich mahogany red, in strong contrast to the steel-gray body. Mangabeys have white eye-lids, which may be rolled upward and flashed in several ways to appear very striking. It has been suggested that these movements form crude "conversation" or signalling among members of a troop.

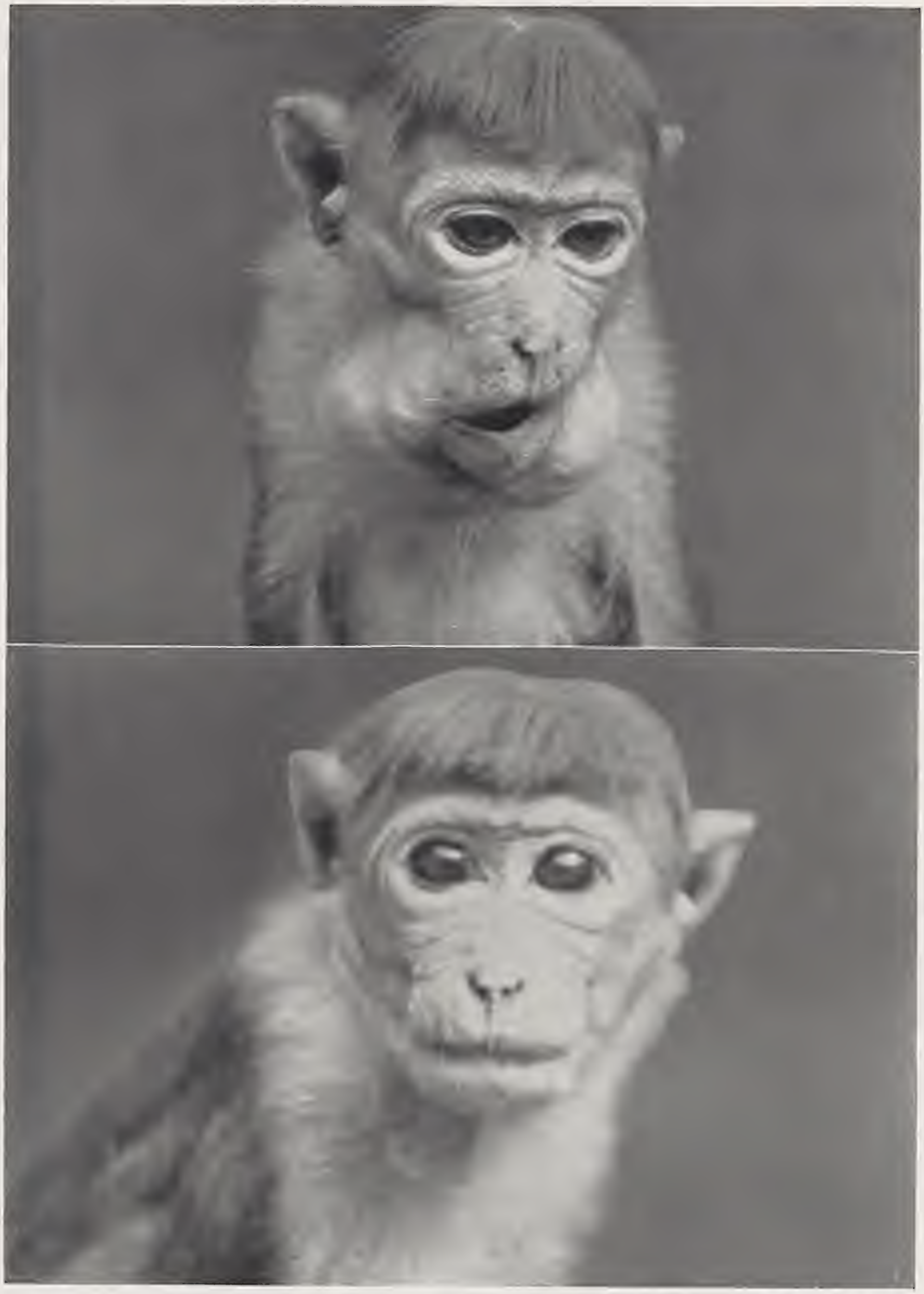


Bonnet Macaque, *Pithecus sinicus.* (Immature). The vigorous enjoyment of a favorite morsel is followed by storage of portions of it in anticipation of disturbance from a neighbor, as shown in the following illustration. (Lower) Even liquid food can be quickly stored in the cheek pouches, as illustrated in the disposal of the egg, to be slowly swallowed in delectable fashion when all danger has passed of the prize being snatched by some watching rogue. *Photograph by R. L. Ditmars.*



Bonnet Macaque. *Pithecus sinicus.* Southern India. An immature example of a species closely related to the Toque Macaque, but differing when adult in the hair growth of the head being higher upon the forehead. This and related species are characteristic in thick hair radiating from a central portion of the head. They have quite long tails. The face is curiously wizened, with a great mobility of expression.

(Lower) Toque Macaque, *Pithecus pileatus.* Ceylon. The curious growth of hair of this young specimen indicates the luxuriant head decoration which appears with maturity, when the mass of hair falls well over the eyes. This is one of the smaller, long-tailed macaques and is readily tamed. *Photograph by R. L. Ditmars.*

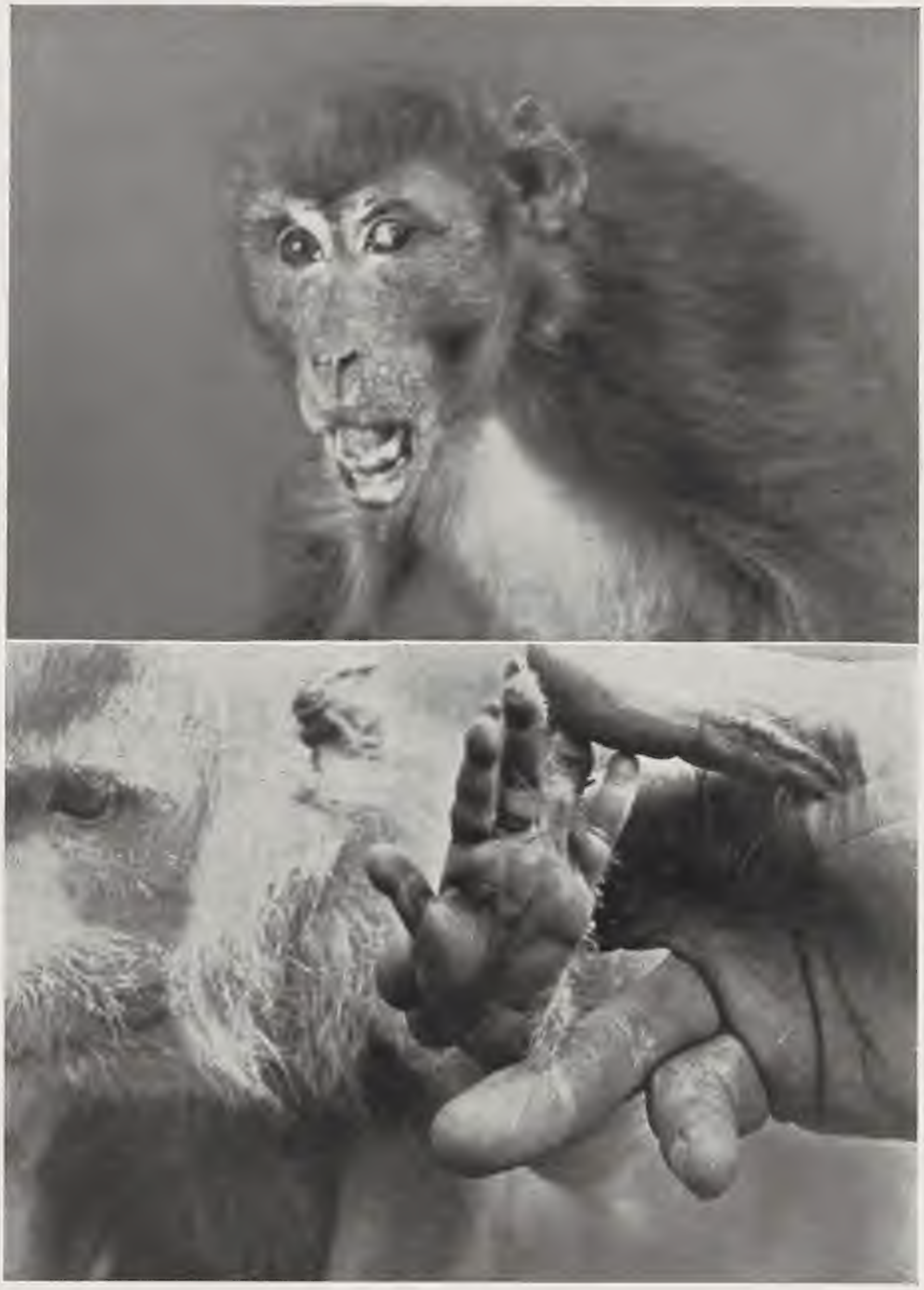


Toque Macaque, *Pithecus pileatus,* Ceylon. Elastic cheek pouches are being quickly and generously stored. This is a provision to prevent robbery from a neighbor and also to hastily gather food from a hazardous place and spryly depart to consume it at leisure. The food is then pushed into the mouth by outside pressure of the hands and fingers. Cheek pouches exist only among Old World monkeys.
(Lower) Development of hair appears as if trimmed. Thickness of the hair and the manner in which it falls about the face varies greatly among individuals. It is interesting to note that a number of species of monkeys show marked individual differences in facial expression. *Photograph by R. L. Ditmars.*



Common Macaque; Crab-eating Macaque, *Pithecus irus.* Indo-Malayan Region. Of the entire Macaque genus of over fifty species, this monkey and the Rhesus are the most commonly seen in captivity. It is hardy, intelligent and friendly, although the latter condition is doubtful with older males, which have greatly enlarged canine teeth and take pride in showing them in simulated yawns. This is one of the long-tailed members of a genus in which tails vary from full length of head and body to a mere vestigial appendage.

Photograph by R. L. Ditmars.



Common Macaque, *Pithecus irus.* Changes of facial expression are almost instantaneous and quite varied, and anyone who has sympathetically observed monkeys can readily recognize common expressions indicating curiosity, surprise, pleading, satisfaction, fear and anger, the latter illustrated here by an old male example. (Lower) The hand of the common Macaque has four well-developed fingers and a strong opposable thumb which are in marked contrast to the elongate fingers and weak, barely opposable thumb of most New World monkeys. Compare the illustration with the photograph of an imprint from the same hand.
Photograph by R. L. Ditmars.

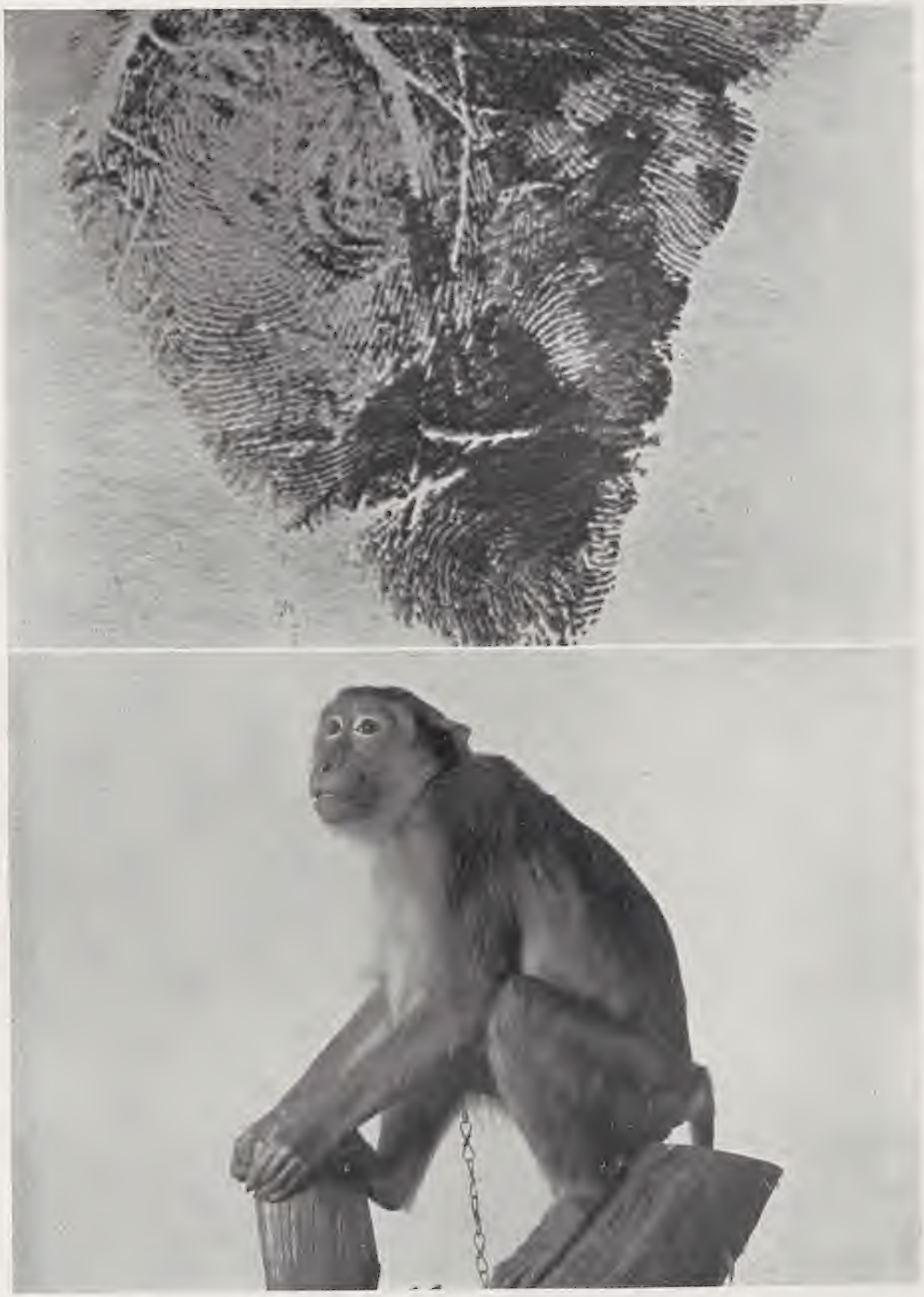


In this hand print of a Common Macaque, the texture of the palm illustrates the marked difference in the lines from that of the human hand, where an imprint would show parallelogrammic lines at the bases of the fingers. Here these markings are of concentric pattern, like the texture of human finger-tips. Note the circular texture at the base of the thumb. *Photograph by R. L. Ditmars.*

(Lower) Japanese Macaque and Young. This baby is five months old, and is not allowed to stray from the mother for an instant. It can play within a yard of her, but a watchful gaze is always turned in its direction.

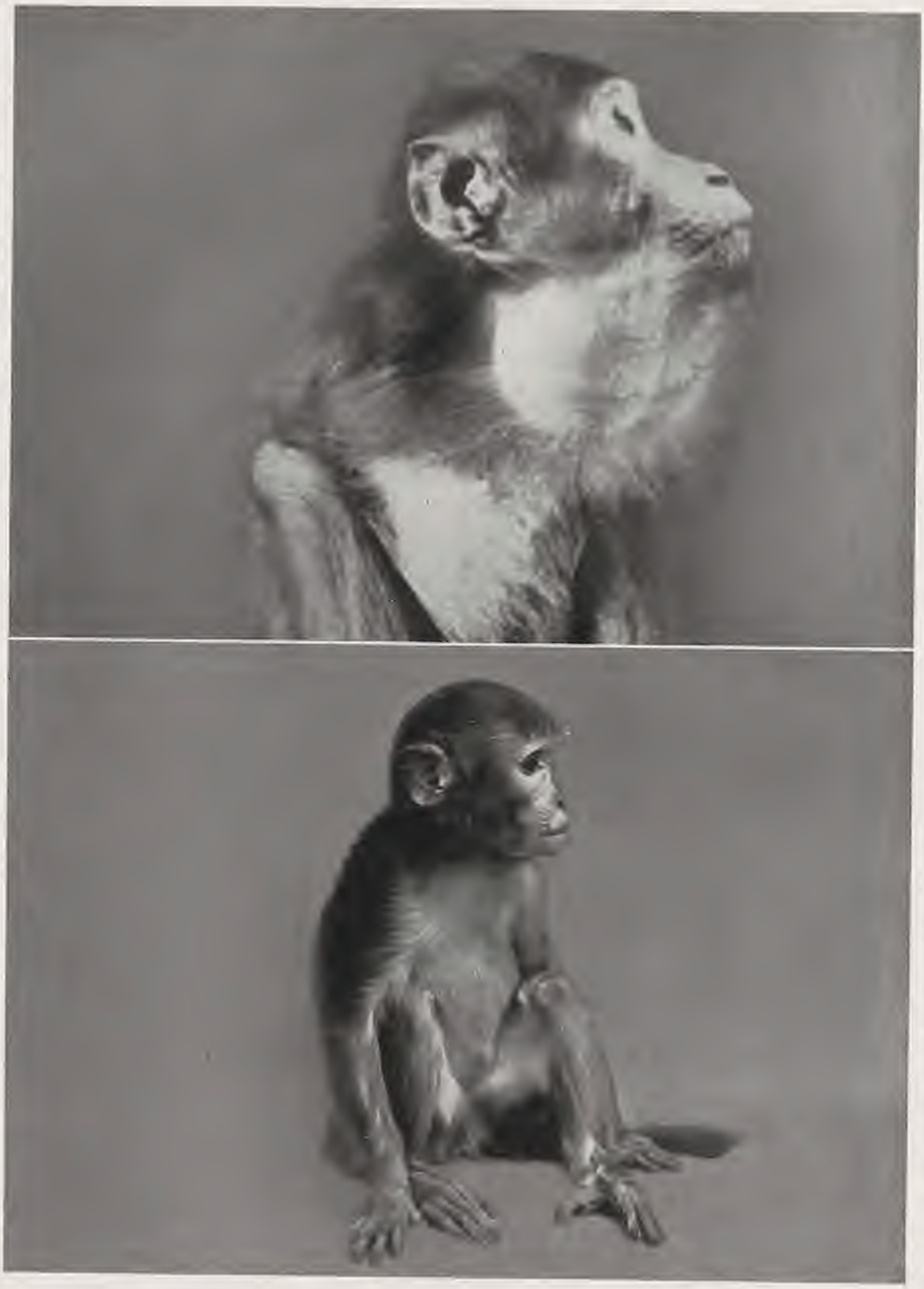


Japanese Macaque, *Pithecus fuscatus*. Japan. Powerful, savage and active, this large species is able to endure the rigors of actual winter. With several other hardy species of its genus, it ranges well into the temperate zone and away from normal areas inhabited by the monkey races. In this climate it will thrive out of doors throughout the winter. The face is brick red; the tail merely vestigial.



Compare this illustration with the hand print of the Common Macaque. It will be seen that the characteristics of concentric lines at the base of the fingers, and a larger area of similar texture at the base of the thumb, follows through to this short-tailed species.

(Lower) Pig-tailed Macaque, *Pithecus nemestrinus*. Indo-Malayan Region. Ranking among the largest of its group, being about two feet high in a sitting position. The tail is short, curled and pointed, hence the name. Young specimens are particularly intelligent and adaptable to training, but as with most of the larger monkeys, become treacherous and savage as they mature. *Photograph by R. L. Ditmars.*



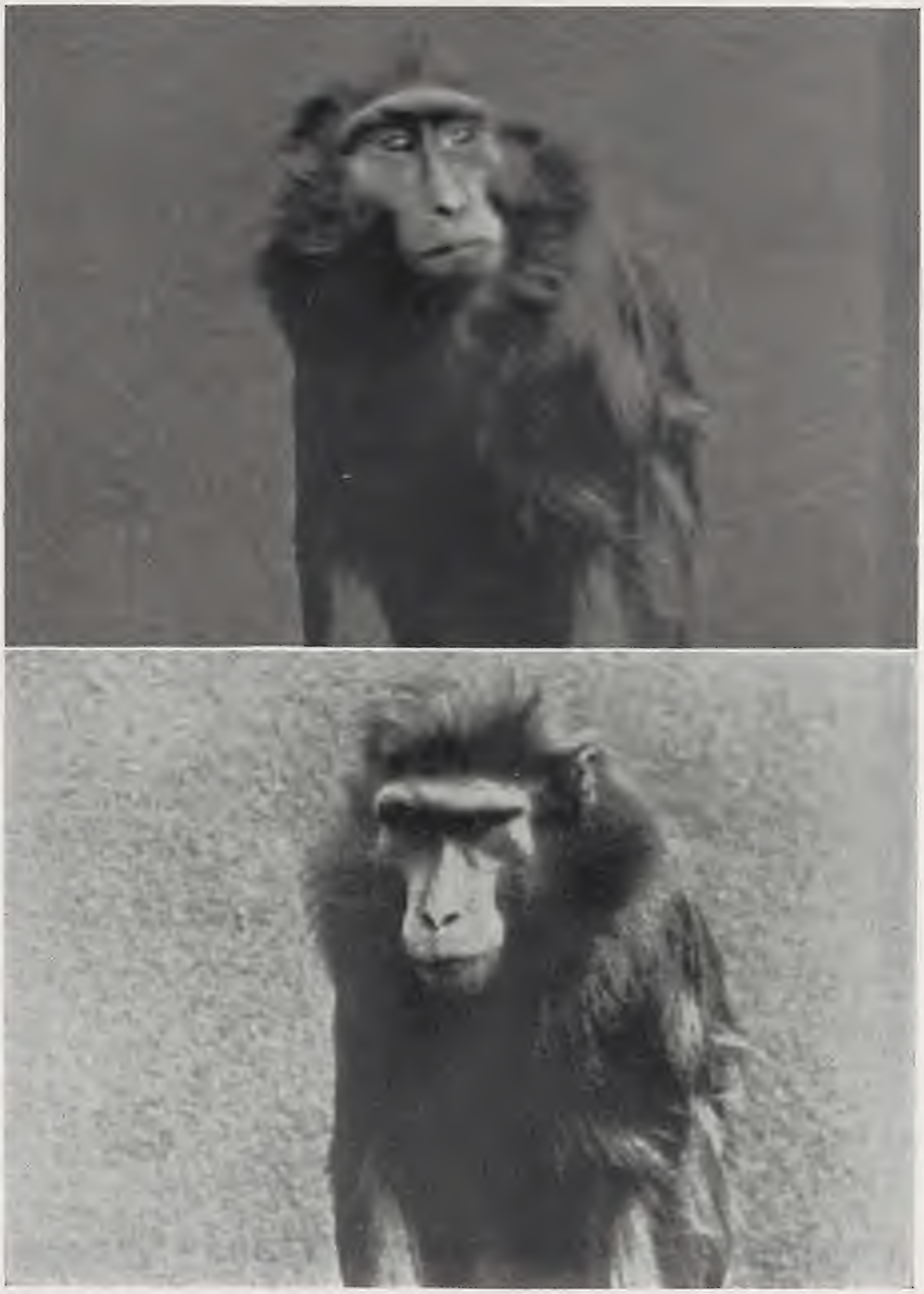
Sitting barely fourteen inches high, this young Pig-Tailed Macaque has quickly stored an entire banana in its two, greatly elastic cheek pouches, which project downward and outward. This food is afterwards leisurely consumed by compressing the pouches with the fingers. *Photograph by R. L. Ditmars.*

(Lower) Rhesus Monkey, *Pithecus rhesus.* India. Possibly the most familiar among the Macaques, and very commonly seen in captivity. It is exceptionally hardy and able to endure the cold of winter. It is a large monkey, with face of reddish tingue, and a body particularly compact and strong. The tail is short and stout, and proportionately but a trifle longer than that of a dock-tailed dog.

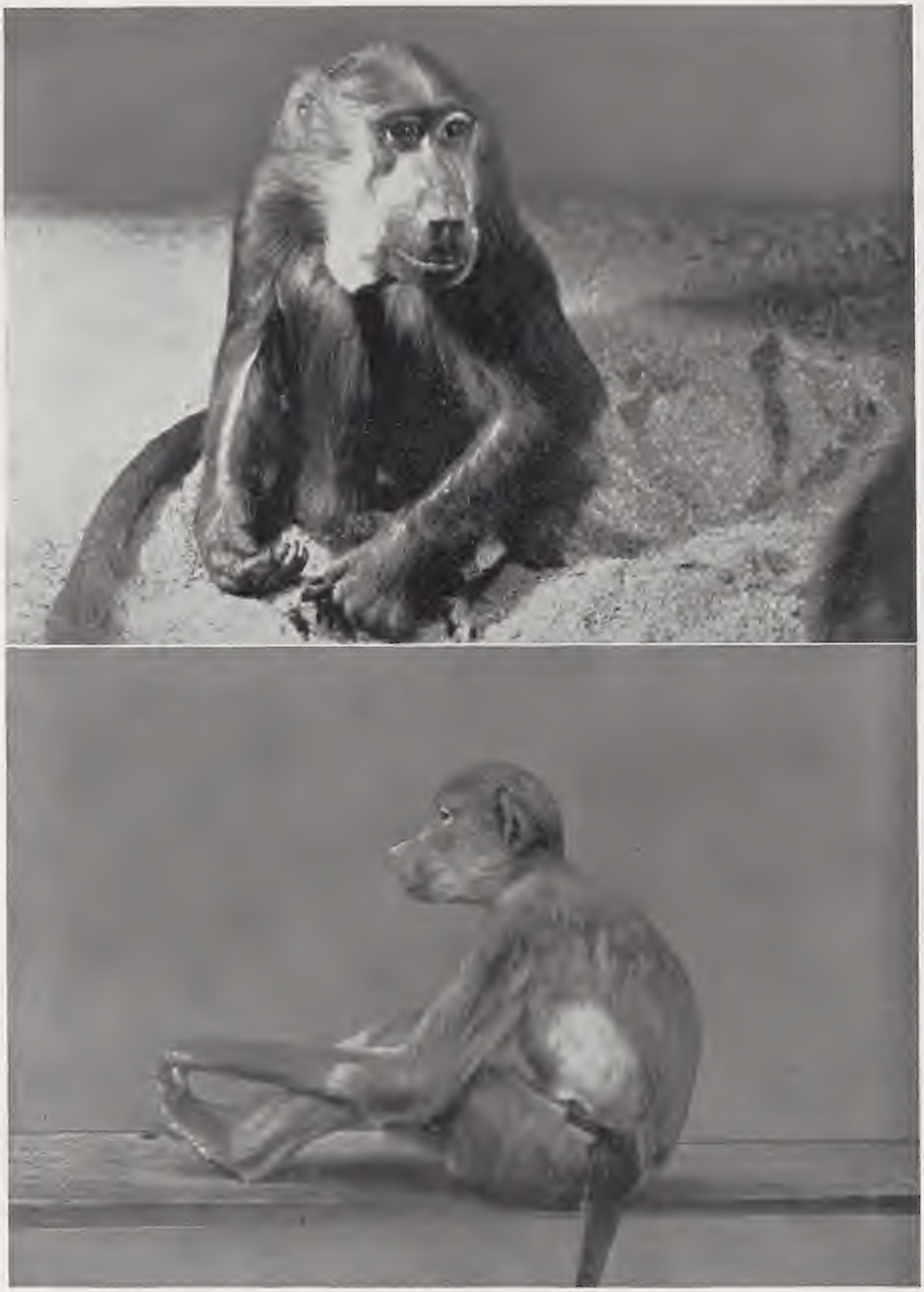


Barbary "Ape," *Simia sylvanus,* Morocco and Algeria. It is a true Macaque, but accorded generic distinction from its lack of a tail. It is the only member of the Macaque group inhabiting Africa. This is the famous "Ape" of Gibraltar and the only monkey living on European soil. It is thought to have been brought there by the Moors. It is doubtful if more than a few dozen exist upon the "Rock" at the present time.

(Lower) Celebes Black "Ape," *Cynopithecus niger.* Celebes and Aru Islands. A large and powerful animal, improperly called "Ape" owing to its lack of tail. The face presents an interesting study in its excessive length, long, thin nose, and the bony, projecting brow. *Photograph by R. L. Ditmars.*



Celebes Black "Ape"



Guinea Baboon, *Papio papio.* West Africa. There is little structural difference between baboons and monkeys, and both are included in the same family. Baboons have a longer and more dog-like head than monkeys, the elongation particularly relating to the snout. They are also more terrestrial and live in more open places. This immature example has one of the cheek pouches distended with food.

(Lower) Long-Armed Baboon, *Papio cynocephalus.* Compare the length of arm development with that of the Anubis Baboon. Such development enables this species to move at a particularly swift and ambling gait. *Photograph by R. L. Ditmars.*



Long-Armed Baboon, *Papio cynocephalus.* Central and East Africa. Tall and ambling, the species is distinct enough to be recognized at a glance. White eye-lids are said to be used in "flashing" warning signals to members of the roving group.

(Lower) Mandrill, *Papio sphinx.* West Africa. Armed with enormously developed canine teeth, sharp as daggers, this is the most forbidding of the baboons. As a sinister touch to such a dramatic type, the cheeks are swollen, deeply ribbed, and of vivid blue; the nose is fiery red. A golden beard is also in contrast to the dull olive of the body. *Photograph by R. L. Ditmars.*



Skull of the Mandrill. Showing the enormously developed and daggerlike canine teeth. Photograph published by courtesy of the American Museum of Natural History.



Gelada Baboon, *Theropithecus gelada,* Southern Abyssinia. Differing from the Mandrill, which is tailless, the Gelada is provided with a sweeping, tufted appendage. A flowing mantle of lustreless, brown hair falls from the shoulders. On the breast is a vivid crescent of bare, red skin. With its hideous grimaces, cackles and warning calls, its mane and tufted tail, it imparts the impression of an insanely animated caricature of a lion.



Red Howling Monkey, *Alouatta seniculus.* Northern South America. Sitting a full two feet high, adult Howling Monkeys are the largest of the New World monkeys. A curious "sound-box" in the throat enables them to utter long, deep roars. Note the crude use of the thumb, which is but slightly opposable—a characteristic of New World monkeys.

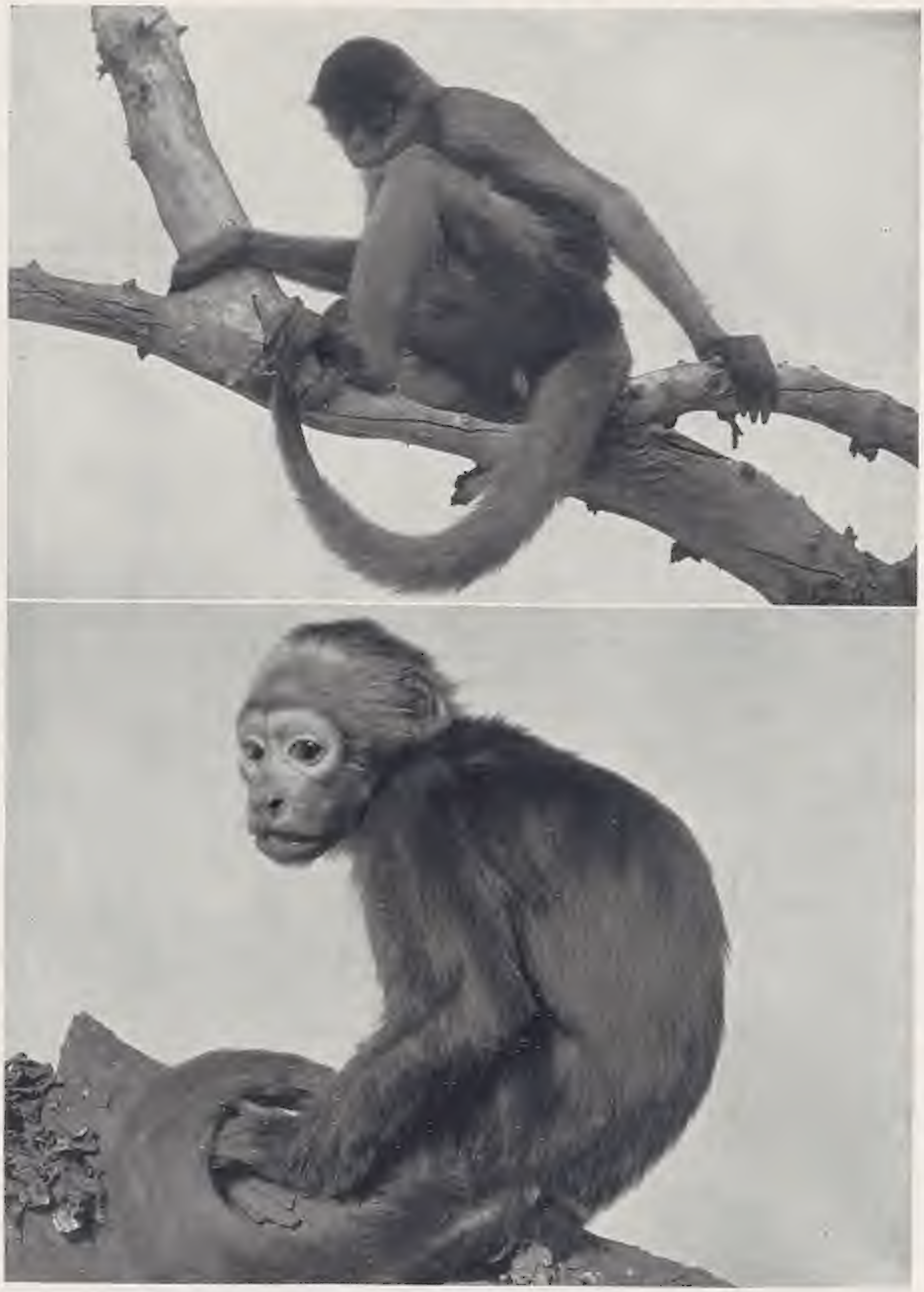
(Lower) Compare the photograph of this young Howling Monkey with that of the adult specimen. This animal is barely a year old and will require three to five years to grow the beard and develop the rather sinister countenance of maturity. *Photograph by R. L. Ditmars.*



Woolly Monkey, *Lagothrix lagotricha.* Upper Amazon Region. Clad in soft, thick and silvery gray hair, which grows close and upstanding, like wool, this animal appears to have a curious pelage for the tropics. Its use of the end of the prehensile tail as a prop is a common habit among American monkeys, enabling them to stand erect, and illustrating the general use of that valuable and highly specialized appendage.



Black Spider Monkey, *Aeleus ater*, Panama to Colombia. Spider monkeys form a genus of twelve distinct species. They are the most slender of the American monkeys, strictly arboreal, have excessively elongated hands, and are characteristic in being thumbless. The tail is prehensile and as useful as a fifth limb.



Geoffroy's Spider Monkey, *Ateleus geoffroyi.* Central American and Northern South America. The thumbless hand, with its four long fingers, is clearly shown.

(Lower) White-Throated Capuchin, *Cebus capucinus.* Nicaragua to Colombia. A common representative of a large genus of American monkeys. These are the most abundant and familiar of the New World monkeys, and are often called Sapajous or Ring-tails, owing to their habit of carrying the terminal third of the tail tightly coiled. That appendage is prehensile, but the under portion is not bared for positive grasping, as are the tails of the Howlers, Woolly and Spider monkeys. *Photograph by R. L. Ditmars.*



(Upper) White-Throated Capuchins. (Lower) Tufted Capuchin, *Cebus cirrifer.* Southern Brazil. Among the capuchins or sapajous there is considerable variety in length of body pelage and head tufts. Some species exhibit a pompadour effect of raised but smooth hair, directed backwards. This species illustrates a small group with particularly luxuriant head tufts, directed upward, over the forehead. It is either black or very dark brown. *E. R. Osterndorff.*



Woolly Saki, *Pithecia monachus*. Basin of the Amazon. While the Saki appears to be luxuriantly clad for an animal inhabiting the hottest part of South America, the hair is extremely soft and light, and is ruffled by the merest breeze. This is quite a small monkey, and represents a group of eight species. The heavily haired tail is not prehensile. The Sakis are largely insectivorous.



Woolly Saki, *Pithecia monachus.*

(Lower) Owl Monkey, *Aotus trivirgatus.* Upper Amazon Region. A small group of a dozen diminutive species is known as the Owl Monkeys. All are nocturnal and have very large eyes, hence the name. They are strictly arboreal and hunt for small birds, lizards, snakes and insects. *Photograph by R. L. Ditmars.*



Owl Monkey, *Aotus trivirgatus.* (Lower) Black-Eared Marmoset, *Callithrix penicillata.* Marmosets and Tamarins are the smallest of the monkeys and among them there is a great variety of coloration and decorative tufting of the hair. The species range in size from that of a squirrel to much smaller types, and with some the head is about the size of a large marble. Insects form a considerable part of their food. *Photograph by R. L. Ditmars.*

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BEARDED DRAGON . . . . . *Photograph by Charles Barrett* *Cover*

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Bearded Dragon, *Amphibolurus barbatus* is the largest of this genus and ranges over nearly the whole of Australia. When alarmed or angered it spreads its spiky neck-frill and hisses very much like a snake. They are fond of perching on tree-stumps or fence posts where they bask in the hot sun.

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

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VOLUME XXI JULY-AUGUST, 1928 NUMBER 4

LIZARDS IN AUSTRALIAN WILDS*

By CHARLES BARRETT, C.M.Z.S.

The illustrations are from photographs taken in Australia by the author

DRAGONS in our day! Folks smiled, or wondered, when the first reports of those giants of Komodo appeared in the newspapers. But some of us, naturally, thought: The "goanas" have big cousins on that tropic isle—the dragons of Komodo are Monitors. We have no iguanas in Australia; but our Monitor lizards are known, throughout the land, as "goanas," and their nickname is never likely to be changed for one more fitting. After all, it is merely a label; and more easily remembered than *Varanus,* Lace-lizard, or Gould's Monitor.

We are rich in lizards, both numbers and variety. Many kinds have I hunted with a camera, from finger-long sun-lovers to Monitors measuring as many feet as the pygmies do inches. Rather good sport; for lizards, as a rule, are swift upon their ways, and wary. But there are notable exceptions. And since this is not a systematic paper, but a rambler's gleaning from notebooks and memory, I may begin with the indolent species.

Our champion slowcoach is the shingle-back or stump-tailed Lizard (*Trachysaurus rugosus*), which measures up to about fourteen inches in length, and has a tail that lacks only the mouth and eye-marks to be another head in appearance. The tail, like the head, of this sluggish, stout-bodied reptile, is thick and short and flattened. At a casual glance, from a few yards away, you might mistake shingle-back's head for its tail and *vice versa.* A close up view is not deceiving; but *T. rugosus* certainly is one of the strangest of all the Australian lizards, as regards its tail and armour of dark-brown or variegated "shingles." The tongue is of a purple-black color.

Shingle-back, short-legged and deliberate in its movements—it seems to "drag its slow length along" and leaves a broad trail in dust or sand—Shingle-back has another claim to distinction besides novel appearance; it is a snake-killer. Bushmen, round the camp-fire, tell snake yarns, and often you may hear old Shingle-back praised as an enemy of venomous serpents.

Sluggish, and loving to bask among rocks or in sere grass by the wayside, shingle-back, at need, can be formidable to the swift, gliding serpent. Getting a grip with strong jaws, the lizard holds on like a bulldog. In handling *rugosus,* it is well to keep your hand out of range of its bite. This species has a habit, when touched, of flexing then relaxing its body sharply, making boomerang-shaped movements, as it were, after the manner of some sphinx-moth caterpillars. It is viviparous, bringing forth, not a brood, but one offspring, alive.

Motor cars take heavy toll of Shingle-backs on the country roads. For these lizards *will* cross busy highways through their haunts, and motorists cannot dodge all that they see; many are not even noticed until crushed by the wheels. Along a mile of road in Mallee country, where they abound, I counted, one

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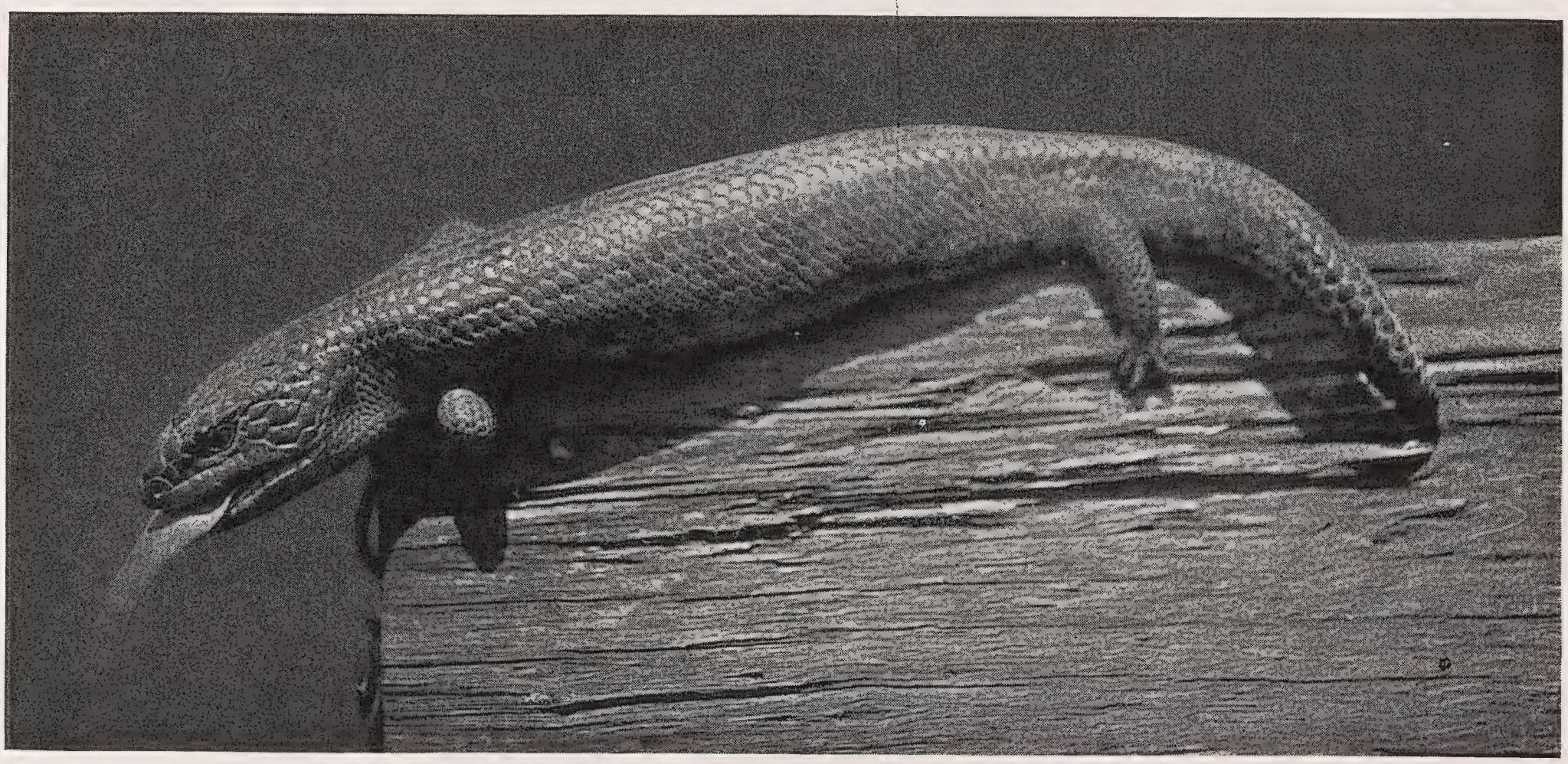
Mitre Rock in the Grampians Range, Victoria. This rocky country is the haunt of the shingle-back or stump-tailed lizard. In the spring the Grampians are alive with wild flowers of many species.



Stump-tailed Lizard, *Trachysaurus rugosus* is one of the strangest of all the Australian lizards. At a few yards distance, its tail lacks only mouth and eye-marks to be a head in appearance. It is a snake killer, a formidable enemy of the many venomous reptiles with which Australia abounds, and the reptile when seized is helpless in its bulldog-like grip. This genus is represented by but one species.

day, nearly twenty car-killed shingle-back lizards. Hundreds must be crushed every summer, in Victoria alone.

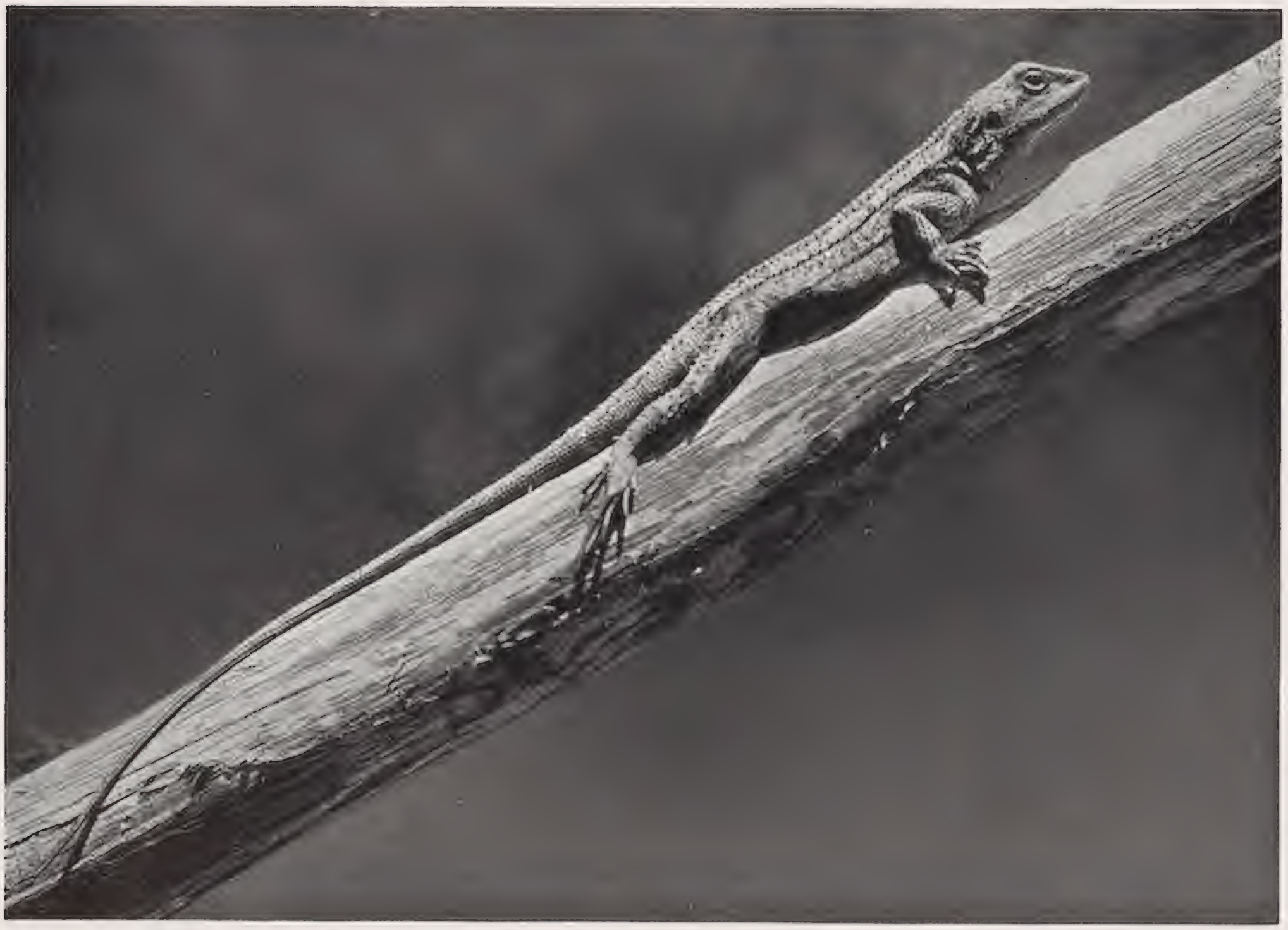
The genus *Trachysaurus* is represented by one species only; whereas *Tiliqua* has five or six members. These are the blue-tongued lizards, indolent, but more active than shingle-back, and built on more graceful lines, with pointed tail instead of a "stump." They are popular as pets, and I have several at large in my wildflower garden. Sometimes they wander, and appear in a garden whose owners are not nature lovers. Cries of alarm took my wife across the street, one morning. She found three frightened women, armed with golf clubs, menacing a harmless lizard, not eighteen inches in length. It was "Bluey," one of my tame *T. scinoides,* which had gone on a ramble. The golfers were really annoyed as well as scared; and threatened to re-



Blue-tongued Lizard, *Tiliqua scinoides* a more graceful form than the shingle-back, derives its common name from the rich color of its tongue. They are very gentle and are popular among nature lovers as interesting pets. They are fond of milk, among other foods, which they lap like a cat.



A dry country species of the Blue-tongued Lizard, *Tiliqua*. This species is distinguished from the preceding form by the bands around its body.



Grey Bloodsucker Lizard, *Amphibolurus muricatus* is common on the dry hill slopes about Melbourne, the capital of Victoria, and is widely distributed throughout Australia. Swiftness of movement is its measure of safety when pursued by an enemy; its speed not being excelled even by the whipsnake.



Bearded Dragon, *Amphibolurus barbatus* presents a truly terrifying appearance when he spreads his neck-frill. This odd reptilian form is largely a ground dweller. His ferocious pose is really a bluff; his bite is in no sense as terrible as his aspect.



A glimpse of the Central Australian country. The author is standing in porcupine grass (Triodia) which shelters, as a rule, many of the smaller lizards, hosts of insects and spiders.



port me to the police, for "keeping poisonous reptiles" in Suburbia! When my wife lifted "Bluey" and stroked his scaly head and body, the trio gasped, and wondered!

Well, I like lizards, and commend any of the Blue-tongues as pets. They are easily tamed, and feed on milk, lapping it up as a cat does, scraps of meat and greens of the "fleshy" kind. They are also fond of Capeweed flowers. Their tongues, frequently extruded when they are handled, are of a lovely Prussian blue color.

Our little grey "bloodsucker"—the popular title for *Amphibolurus muricatus*—is very common in sandy districts and on the drier hill slopes around Melbourne (the capital of Victoria); and enjoys a wide range in Australia. About a foot in length, it has a tail twice as long as its body, and is camouflaged by its colors and pattern marks when resting, as it often does, on the grey-brown bough of a tree. It is both bold and wary; an amusing small creature, which basks in sunny spots, ready to dart off at a sign of danger. And yet, if you chase one, on a piece of open ground, it may stop and face you for a moment; even make a menacing run forward. All bluff, for it is easier to capture a whip-snake than this common dragon, libelled by its nickname, "bloodsucker." My photographs were not obtained without trouble.

There are so many species of the genus *Amphibolurus*, all called "dragons" in our natural histories, that I shall mention only a few of the more familiar kinds. The bearded dragon (*A. barbatus*), length up to about twenty inches, is the giant of the genus, and ranges over nearly the whole of Australia. It is plentiful in the drier country, and I have met with it in all my rambles through the Malee — our "Land of Little Rain," now enriching wheat-farmers, who get water supplies mainly from bores and big dams.

The bearded dragon, when alarmed or angered, opens wide its jaws,





Upper—Frilled Lizard, *Chlamydosaurus kingii*, attains a length of three feet and is remarkable for its huge neck-frill which it expands under stress of excitement presenting with wide open jaws a truly formidable appearance. When running, which it can do most swiftly, it uses the hind legs, solely, and assumes a nearly erect posture. Their tracks on moist ground are like those of a bird or miniature Dinosaur. *Center*—Australian bushman of the Arunta tribe, Central Australia. The aborigines include the lizards in their diet. *Lower*—Painted Dragon, *A. pictus* is a species of the most brilliant coloring.



Among the great numbers of Australian lizard species there are many geckoes. One, *Nephurus asper*, has a curious bulbous tail which tapers toward the end, where instead of a point it ends in a globe-shaped knob. The gecko pictured is alive in the author's collections; it has three tails; probably an abnormal state.

spreads its spiky neck-frill or "beard," and hisses just like a snake. It does not hesitate to bite fiercely at a hand—or a booted foot—placed near its head, but the bit is not very painful. Yet its boldness and bluff often are effective against its natural foes, and may even frighten a person unfamiliar with the ways of lizards. A unique photograph shows exactly how the bearded dragon plays its game of bluff. This queer reptile is largely a ground dweller, but, liking a place in the sun, is commonly seen basking on a tree-stump or a fence-post.

The painted dragon (*A. pictus*) is a beauty, especially when inhabiting arid country, where the landscape, under a cloudless sky, gleams resistance to the sun. Here, the painted dragon wears a coat of many colors—brick-red and yellow and blue. Legs and tail are of the sky-color, while the blue sides of the body—red above—are yellow spotted. There is variation in brilliancy, and, in Victoria, I have seen examples of *A. pictus* that were not at all showy—is there perchance a race of painted dragons that prefers softer tones than are fashionable in the Central Region?

During a recent journey in Central Australia I was among the Aruntas, a Stone Age People, rapidly failing, or becoming "civilized" as settlement advances in their territory. Blacks with white neighbors may benefit materially—often they degenerate but lose much of their interest for the anthropologist. Many ancient customs are changed or forgotten, excepting by the wise old men. Clothes are no blessing to a people used to nudity, and rob them of any natural dignity which they may have possessed. An Arunta man in his primitive state, as he may still be seen in some localities, is far more pleasing to the eye—and cleaner—than one of his tribe in shop-made clothing.

It was in the Arunta country that I made studies of lizards, regarded as good "tucker" (food) by the aborigines. Even the civilized blacks, as a rule, are catholic in the matter of food. They do not despise "goana" steaks because they have become used to Mission or Station (ranch) rations. And those that roam the wilds, living the old, immemorial life of nomads and hunters, relish nearly every creature that creeps or crawls or flies, or dwells in water. Only, each individual, respecting the law, refrains, excepting under very special circumstances, from eating his totem animal. An "emu" man doesn't dine on emu flesh, nor a "lizard" man upon lizards. The totem system is complicated, like the marriage laws; but broadly, is concerned with restrictions, which are rigidly adhered to, with, perhaps, occasional exceptions. All that is edible is eaten by the aborigines. And lizards very often are included in the menu. One method of securing the smaller kinds that hide among the spinifex or porcupine-grass (*Triodia*), is to set fire to the big tussocks, much too prickly to be searched with the hand or naked foot—the spikes will even lacerate boot-leather! Lizards, spiders, cockroaches, beetles and other "small deer," are driven into the open by smoke and flame, and thus captures are easily effected. Some mammals also are among the victims—speared or killed with a waddy (club). Burrowing

species are dug out by the gins (women); and big reptiles run down and speared, or killed in some manner.

Lean were many of the aborigines I saw in Central Australia; others looked better fed, and some were plump, the picanninies especially. I cannot call these people lizard-eaters, meaning that they subsist chiefly upon those reptiles; but certainly, lizards form a fair proportion of their dietary, in places where lizards abound.

An Arunta tradition relates to the Numbakulla, who changed themselves into small lizards. Devil-devil men killed and devoured all but two of the Lizard folks. I visited a spot, in the olden days a Lizard totem centre, where my companion, one wise in native lore, and tradition, told of wonderful happenings to Lizard men and women, and other totem groups in the Alchera—the "dream-time," or dim past, when the Arunta's ancestors (totemic) existed.

So lizards, you see, are associated with savage life in Central Australia.

From a semi-civilized blackfellow, clearly not a "lizard" man, I obtained a living example of *Moloch horridus,* the "thorny devil" lizard. In grotesqueness it has American rivals, the horned toads; but *Moloch,* perhaps, is even more strange in appearance than any species of *Phrynosoma.* As a pet, *Moloch* is engaging, though not always easy to keep, since it is an ant-eater, and does not accept ants of any kind offering; in fact, it has decided preferences. One of my tame "devils" had the freedom of house, yard and garden. He came to an untimely end, being trodden upon by a heavy-footed maid, while crossing a darkened passage.

"Thorny" may fast for several weeks, then enjoy a gargantuan meal—for a creature less than a foot in length. Picking up ants with his slender, sticky tongue, as they issue from their citadel, near which he is lying, a *Moloch* lizard may eat a thousand or more before hunger is satisfied! Small black "sugar" ants (*Cremastogaster sp.*) especially are relished by this odd-looking lizard of ours, whose head is horned and the body beset with spikes, or "thorny." In hot, dry, sandy country—the "Land of Little Rain"—this species is not uncommon; it lives where ants are legion. And, by the way, no country is so rich in ants as Australia, with nearly 1,000 known species and varieties, including the largest in the world, one of the "bull"-ants (*Myrmecia sp.*).

Chlamydosaurus kingii is another notable Australian reptile, commonly called the frilled lizard. It has a very long tail, a slender body, fairly long legs, and a big neck-frill, which is expanded when the lizard opens its jaws widely. A full-grown specimen measures about three feet in length, the tail included. Facing a foe, the frilled lizard looks fearsome; but, usually, it runs for safety, semi-erect on its hind legs, placing only the three central digits on each foot on the ground. Its tracks in the dust or on moist ground, might be the footprints of a bird, or a miniature Dinosaur! Merry chases after these lizards I have had in Queensland wilds; without making a capture. But I succeeded in photographing one, suspicious and at gaze, on a rock. It raced away, a moment after the camera shutter had clicked.

Among our several hundred kinds of lizards are many curious geckoes. *Nephurus asper,* under five inches in length, has a remarkable tail, swollen at the base, tapering then, and ending, not in a point, but a globe-shaped knob. This is the famous "barking" lizard. When annoyed or frightened, it makes curious coughing or barking sounds, at the same time jumping sideways. Another species possesses a leaf-shaped tail, and a head reminding one of that of a newly-hatched sparrow or other small bird. Geckoes in my collection include one with three tails, resembling a tiny hand. This lizard is alive, not in spirits, and often its tail is seen moving, just like nervous fingers. Under the loose bark of gum-trees (*Eucalyptus*) and logs on the ground, geckoes of divers kinds lurk. In the tropics, commonly they dwell in houses, and are not unwelcome, because they prey upon insect pests and spiders.

Our Monitors deserve a monograph. And were all the stories regarding giant "goanas" true, the next expedition in search of dragons might come to Australia. One hears of monsters ten feet or more in length. What a battle would be witnessed between a "goana" of this





size and a dragon-lizard of Komodo! There are large tracts of our country unexplored, or little known, where nature may guard secrets still; where, truly, long-haired lizards several yards in length may survive—isolated inland, like the Monitors on the isle of Komodo. But naturalists are unbelieving. We know that an extinct Australian monitor exceeded in size even the *Varanus* of Komodo; but none of the living species hitherto described equals the largest lizard recorded for the isle of "dragons."

An adult lace-monitor (*Varanus varius*), measuring about six feet in length, is a "big goana." Some of the fourteen species described are less than half this size; others even smaller. *V. varius*, often called "Tree-goana," because it is a very quick and skilful climber, is one of the most familiar kinds, abundant in sparsely settled and untamed country. It enjoys a wide range, and is cordially detested by nature lovers, as well as by farmers and settlers. So is its ally, Gould's monitor (*V. gouldii*), which attains a length of four feet or over, and lives on the ground. Both species are raiders and scavengers, too. They are omnivorous. Carrion is greedily devoured, as well as any living creature that a "goana"

Upper—The Lace Monitor is one of the Varanidae, *V. varius,* and when adult attains a length of six feet. They are skilled tree climbers, the long, strong claws being specially adapted for this purpose. *Lower*—The monitors, Varanidae—are called "goanas" by the Australians. This is a young specimen, probably *gouldii.*



some species have become rare in certain districts, while others are fighting a losing fight against "goanas" and domestic cats gone wild.

Changes due to settlement have caused the Monitors themselves to decrease in numbers, or disappear completely from localities where once they abounded. They own a wide realm still, however; and where man does not dwell and seldom goes, may be very plentiful. There are places noted as haunts of these giant lizards, where you might, in the course of a day's ride or a ramble, see scores of "goanas."

The lace-lizard is a handsome reptile, in a livery of, mainly, black and yellow; the tail is banded, in the same colors. "Goana" skins often are tanned, and made into belts, etc., by bushmen. The fat of Monitors is valued, too, as a salve for cuts and sores, sprains and similar ailments.

In my experience, Monitors display a wholesome fear of man, when he's aggressive. But, occasionally, one will show fight. Usually, a "goana," surprised, runs for cover, or if *Varius,* to the nearest tree, up which it races, dodging round the



can secure. They are great enemies of birds, and would put to shame any egg collector, in regard to record "takings." Wholesale nest-robbing is a specialty of the monitors. The lace-lizard is an ogre, both on the ground and among the boughs; *V. gouldii* takes heavy toll, in eggs and young, of the ground - nesting birds, and as a result

Upper—Varanus varius on a lofty perch, forty feet high in a dead eucalyptus tree. Occasionally a big monitor will show fight, but usually they take refuge in flight, ascending lofty trees with surprising skill and speed. *Lower—Varanus gouldii,* lives on the ground. These monitors take heavy toll of the eggs and young of ground-nesting birds.



One of Narborough Island's volcanoes in eruption, December, 1927. This active cone was on the southwesterly side about five miles from the shore. The molten lava poured from a fissure in the side and made its way to the sea through the lava blocks of by-gone eruptions. From a photograph made by George E. Stone.

trunk, until the boughs are reached. It may climb to the end of the topmost branch that will bear its weight. My photograph (unique, I fancy), shows a lace-lizard which has found refuge about forty feet from the ground, in a dead gum-tree. This veteran had a stump-tail, having, doubtless, been caught in a rabbit or fox trap, and escaped sacrificing a portion of its appendage.

"Goanas" have a liking for eggs—the bigger the better. So they are poultry-yard raiders, as well as robbers of wild birds' homes. In Queensland we caught one in the act of raiding a nest-mound of the brush-turkey (*Alectura lathami*). It was digging into the huge mound of forest debris, to reach the eggs, incubating in a hot-bed of decaying leaves, etc. Mound-builders suffer from "goana" raids; but where the fox (introduced from England) roams, have in it a greater enemy. I have seen many nest-mounds of the mallee-hen or lowan (*Leipoa ocellata*) scratched open, with fragments of egg-shell lying around—the work of "Reynard the Fox."

A glance at Australian lizards must not miss the legless slow-worms, which are commonly mistaken for snakes, and suffer accordingly. Fore limbs are lacking, but the hinder ones are represented by scaly flaps, easily overlooked by a casual observer. These little creatures—the larger kinds attain a length of twelve inches to nearly two feet—are very snake-like in their movements, as well as in appearance. The common slow-worm (*Pygopus lepidopus*) has a very long tail, with which it parts quite readily. So brittle is the tail indeed, that if grasped, almost immediately it breaks away from the body—your captive goes free, leaving in your hand a squirming tail. No lizards, perhaps, are more "free" with their tails, than these small, snake-like species.

Snakes, even harmless species, have very few friends in Australia; but lizards, the monitors excepted, are in better case. People either like or tolerate them, or regard them with indifference. A growing body of nature lovers desires protection for all the lesser kinds; and pet lizards, notably blue-tongues, are not so rare. Several naturalists from the United States have visited Australia, mainly for the purpose of collecting reptiles and amphibians. Few countries offer a richer field for studies in reptile life. We need more observers. I have been urged to collect lizards for museum herpetologists engaged in special studies. But I prefer to hunt only with a camera in Australian wilds.

A VOLCANIC AFTERMATH

By WILLIAM BEEBE

THE interest binding the Zoological Society to the Galápagos has been renewed by the success of Dr. Townsend's expedition. News has recently been received bearing on a shift of volcanic activity in this archipelago. It will be remembered that on April 11, 1925, we saw from the decks of the *Arcturus* the first volcanic outbreak on Albermarle which had been recorded on the islands within a century, although Capt. Luby of the U. S. S. *South Dakota* thought he detected fresh steam and lava on the same island in Sept., 1919.

Morrill's experience in February, 1825 is most vivid, and he and his ship almost perished in the explosion of heat, cinders and lava from a crater on Narborough due west of Albermarle, "Galápagos, pp. 401-405." Today his account acquires renewed significance, because an expedition to Galápagos records only eight months ago a great outbreak on this same island. I have the account from George E. Stone who visited the Galápagos in December, 1927, on the G. Allen Hancock Expedition, in the steamer *Oaxaca*. They anchored in Tagus Cove, Albermarle, on December 11th. Mr. Stone has allowed me to quote a few condensed paragraphs from his manuscript notes, and to publish two photographs. These should be compared with the chapter on "The Birth of a Volcano" in "Arcturus Adventure." Stone reports that they saw no signs of the Albemarle outbreak, the volcanic activity seeming to have passed through under-sea channels to the westward.



Lava-streams pouring into the sea on the shores of Narborough. A close-up view of steam-clouds formed by the hot mass meeting the cold water. It flowed at an approximate speed of a mile an hour disappearing into the sea with a continuous bubbling hiss. The water was hot, but not boiling, and at one hundred yards from the shore was not uncomfortably warm to the hand. From a photograph made by George E. Stone.

Mr. Stone writes, "The first night brought us a surprise and a thrill, for no sooner had darkness fully settled than we became conscious of a ruddy glow which rose and fell in the western sky, under the murky clouds in a way which no sunset could simulate. Far off to the left the glow extended, faintly illuminating the clouds, and it dawned on us that to our great good fortune there was a volcano in eruption on Narborough Island, and that our visit had been perfectly timed to permit us to enjoy this unusual sight.

"On the morning of December 13, as soon as the mists had lifted sufficiently to permit us to see the cliffs and safely navigate, we turned southward through the channel between Albemarle and Narborough. The smoke and fog hung so low that for a time we could see no sign of volcanic activity. Presently, however, the sun broke through, and now we beheld a great dome of smoke and steam glowing in the level morning light. On nearer view we saw many distinct columns of steam arising along the coast, where separate streams of lava were flowing into the sea. Occasionally we caught a glimpse of a ruddy glow from the crater, which was comparatively small and located on the southwesterly side of Narborough, approximately five miles from the sea. Apparently the lava was draining from some fissure in the side of the cone and was making its way beneath the scattered blocks of material left from some previous eruption, for between the crater and the shore there was no sign of lava flow, and only the boiling sea indicated its presence.

"Along approximately two miles of coast the activity was general, although concentrated and localized in four or five places, where plumes of steam were continually thrown up.

"Only in two places did we actually see lava streams. Here one flowed with an uninterrupted sweep at a speed of approximately a mile an hour and disappeared into the sea with a continuous bubbling hiss. At another point a stream — slow moving — had partly chilled until it made a vitreous tube through which the viscous mass slowly flowed. At the opening, above the sea, it hung suspended for a moment, then tore away to form a great pasty blob which fell sizzling into the water. Occasionally such a mass seemed to chill so that it formed a rough sphere rather uniformly on the surface, which then exploded like a bomb from steam pressure and shot fragments into the air. Again the waves, mounting high, moved shorewards and engulfed the whole of the lava streams. At such times there would occur a spectacular display, and the steam would billow upwards into great clouds such as those which attracted us from afar. However the whole phenomenon proceeded in so orderly a fashion that there was no hint of a cataclysm. There was a noise of course, but far less than one might expect. The water was hot, but far from boiling at our position, less than a hundred yards from shore. One could hold his hand over-side without serious discomfort. The water about us took on a yellowish tint in contrast to the blue green of colder depths off shore, and we became conscious of a strong sulphury odor and a rank smell as of shell fish or kelp—possibly due to the cooking of the sea-weed and other life which felt the full fury of the inferno along shore. The eruption was so localized that the sea-lions on a little beach a few hundred yards away were left quite undisturbed, and they moved about on the warm sand as unconcerned as though a cosmic force were not in action beside them.

"As we steamed away, the spectacle spread out behind us, so that we could see the crater with its veil of smoke and mark the long line of boiling surf with the columns and curtains of puffing, eddying steam. Further in shore and high above were other craters, long since cooled, marking the sites of eruptions of former times, many of them on a vaster scale, which had provided the building material of these islands. Our experience had given us a hint of great subterranean forces which, uplifting from the ocean's floor, had spent their fury and left these islands in the lonely stretches of the Pacific—the desolate islands of the Galápagos."

MR. BEEBE RECEIVES DEGREES

ANOTHER of the Staff of the Zoological Society has recently been honored, in this instance, by two institutions of learning. Mr. William Beebe has received

from Colgate University the degree of Doctor of Science and that of Doctor of Letters from Tufts College.

Mr. Beebe's exhaustive studies in scientific fields, his widely ranged exploration and travel and his voluminous contributions to the best literature of this country as well as his valued devotion to the objects of the Zoological Society for over thirty years, are well known to members of the Society who will rejoice with him in these justly deserved honors. *Ed.*

GREAT SOUTH BAY AS A SHARK NURSERY

By EDWIN THORNE

Member of the Board of Managers, New York Zoological Society.

THE most valuable contributions to science have been facts relating to some definite subject, patiently accumulated through a series of years within a limited and circumscribed locality. The following come under this heading,—facts which Mr. Thorne has turned over to me and which I offer with slight rearrangement. For more details of some of the earlier records, see *Copeia,* No. 35, 1916, pp. 69-73. The only additional statistic which seems worth while is the comparison of sharks seen in the first and second halves of the seventeen years under consideration.

—*William Beebe*

	No. of days of observation	*Seasonal average of sharks seen*
8 years 1911-1918...	178	183.75
9 years 1918-1927...	124	36.5

SUMMARY OF EDWIN THORNE'S SHARK RECORD IN GREAT SOUTH BAY, LONG ISLAND, NEW YORK

1911-1927, INCLUSIVE

	Days	*No. Sharks Seen*	*Chances*	*Killed*	*Missed*	*Got Off*
1911	14	144	43	12	25	6
1912	22	258	80	28	44	8
1913	18	52	16	10	2	4
1914	19	244	94	21	55	18
1915	19	148	65	29	28	8
1916	31	277	102	46	43	13
1917	24	220	83	36	30	17
1918	31	127	40	24	11	5
1919	16	65	28	23	3	2
1920	15	40	16	7	7	2
1921	15	24	15	8	5	2
1922	12	38	14	10	3	1
1923	6	17	11	8	3	0
1924	17	37	18	12	5	1
1925	16	55	29	16	12	1
1926	12	24	12	9	3	0
1927	15	29	13	6	4	3
Total	302	1799	679	305	283	91
Daily Average.		5.95	2.24	1.	.97	.30

Of the 305 taken, there were 287 female and 3 male New York Ground Sharks; *Carcharhinus milberti,* and 13 male and 2 female Dusky Ground Sharks, *Carcharhinus obscurus.*

On July 14, 1910, a male Spot-fin Ground Shark, *Carcharhinus limbatus* was taken which measured 9 feet 2 inches long, and weighed 300 pounds.

Greatest number killed in one day, 17; in one season, 60.

Carcharinus milberti—Longest, 7 feet 8 inches; heaviest, 184 pounds, 7 feet 2 inches long; average length about 7 feet; average weight about 150 pounds.

29 of these sharks had 255 young, 125 males, 130 females.

Largest litter, 13; smallest, 6; average 8.79.

Most young sharks are born in July. Have killed them with young from June 22 to Aug. 28.

Length of young about 22 inches; weight about 2½ pounds.

Young have no teeth when born.

Young are always born tail first.

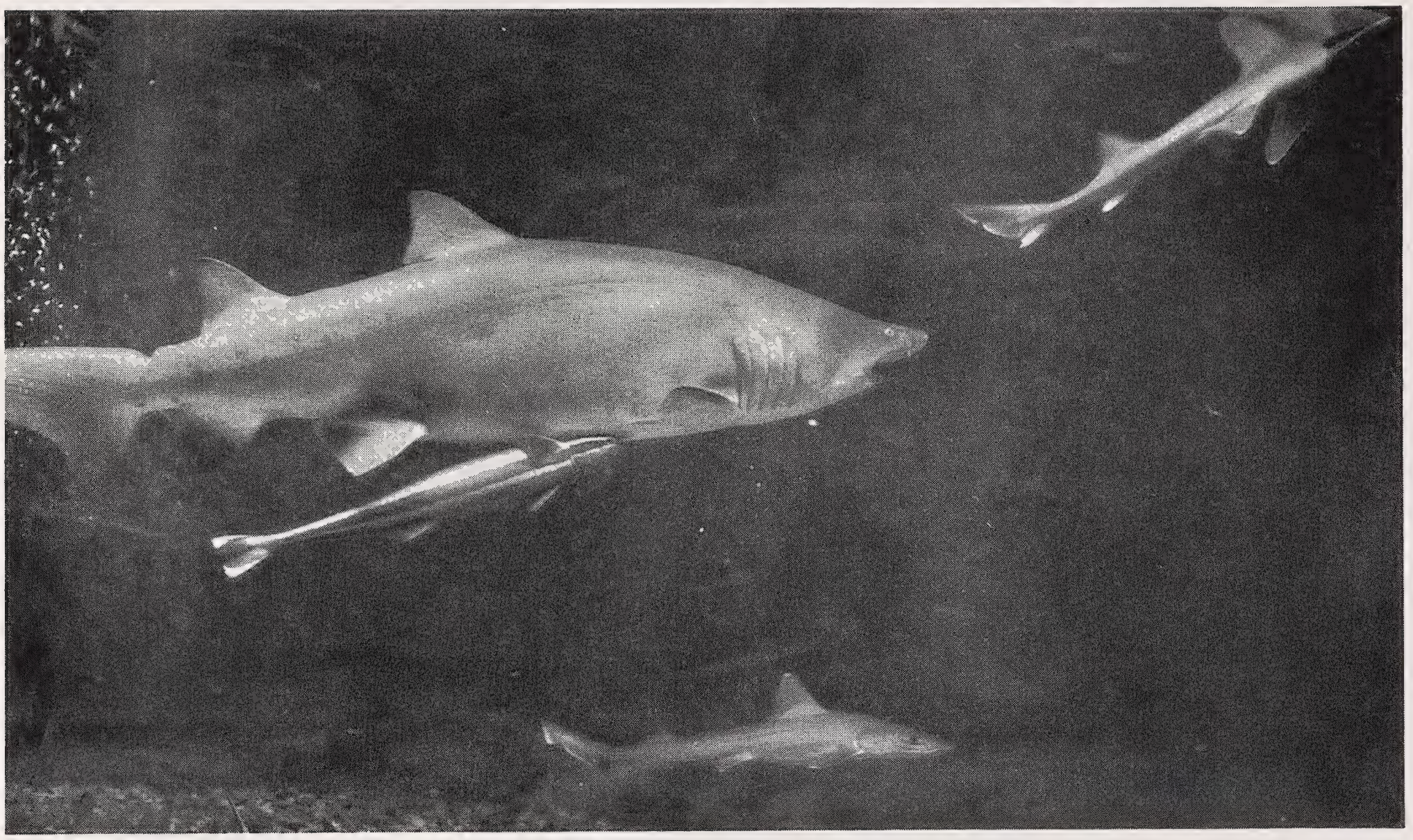
Carcharhinus obscurus—Longest and heaviest, 8 feet 5 inches; weight 322 pounds; average length about 8 feet.

During the years 1902-1906, inclusive, killed 122.

During the years 1907-1910, inclusive, no record kept.

RECORD OF CARCHARHINUS MILBERTI WITH YOUNG

	No. in Litter	*Males*	*Females*
July 13, 1911	10	4	6
June 22, 1912	8	4	4
July 17, 1912	10	4	6
18, 1912	8	4	4
9, 1914	10	2	8
22, 1914	11	2	9
24, 1915	8	5	3
Aug. 5, 1916	10	6	4
1, 1917	6	2	4
4, 1917	6	3	3
July 4, 1918	10	5	5
4, 1918	8	2	6
11, 1918	13	7	6
11, 1918	12	2	10
Aug. 2, 1918	7	6	1
2, 1918	8	5	3
2, 1918	9	7	2
July 5, 1919	7	5	2
5, 1919	6	2	4
5, 1919	11	5	6
6, 1919	8	6	2
6, 1919	9	5	4
11, 1919	7	5	2
Aug. 28, 1920	7	4	3
28, 1920	7	4	3
July 23, 1921	10	4	6
Aug. 6, 1923	12	7	5
July 13, 1925	8	4	4
19, 1925	9	4	5
	255	125	130



SAND SHARK WITH SHARK-SUCKER ATTACHED
Photograph by Elwin R. Sanborn

DATES OF OTHER THAN FEMALE CARCHARHINUS MILBERTI TAKEN

Milberti Males

	Ft.	In.
Aug. 24, 1912	7	—
29, 1916	6	6
25, 1917	6	7

Obscurus Males

	Ft.	In.
Aug. 16, 1915	8	—
23, 1915	8	2
3, 1915	8	1
21, 1916	8	5
21, 1916	8	3
21, 1916	7	8

Obscurus Males (Con.)

	Ft.	In.
July 27, 1917	7	2
Aug. 27, 1917	8	—
15, 1918	8	—
Aug. 26, 1918	8	—
July 12, 1919	8	2
23, 1921	8	—
23, 1921	7	8

Obscurus Females

	Ft.	In.
Aug. 11, 1917	7	1
July 8, 1922	7	—

PLUME HUNTERS OUTWITTED IN FLORIDA

TWO game-law offenders, in possession of the backs of twenty-one egrets taken from birds they had just killed, were apprehended recently by State officers at Gulfport, Florida, and confined in jail pending arraignment before the United States commissioner at Tampa, Florida. This was effected a few days later by a Federal game protector, and the violators were required to furnish bond of $1,000 each. The plumes as well as two shotguns were seized as evidence. Snowy herons, or egrets, from which the plumes known as "airgrettes" are obtained, are afforded protection throughout the year under the migratory-bird treaty act, and persons killing these birds are subject to prosecution in Federal court. Efforts will be made to have the two offenders arraigned at the next term of Federal court for the southern district of Florida.

As a result of the operations of Federal game protectors in Florida and other States, the work of plume hunters has been restricted, and persons who formerly derived material financial profit by engaging in this unlawful business have had to seek other employment. *U. S. Dept., Agriculture.*

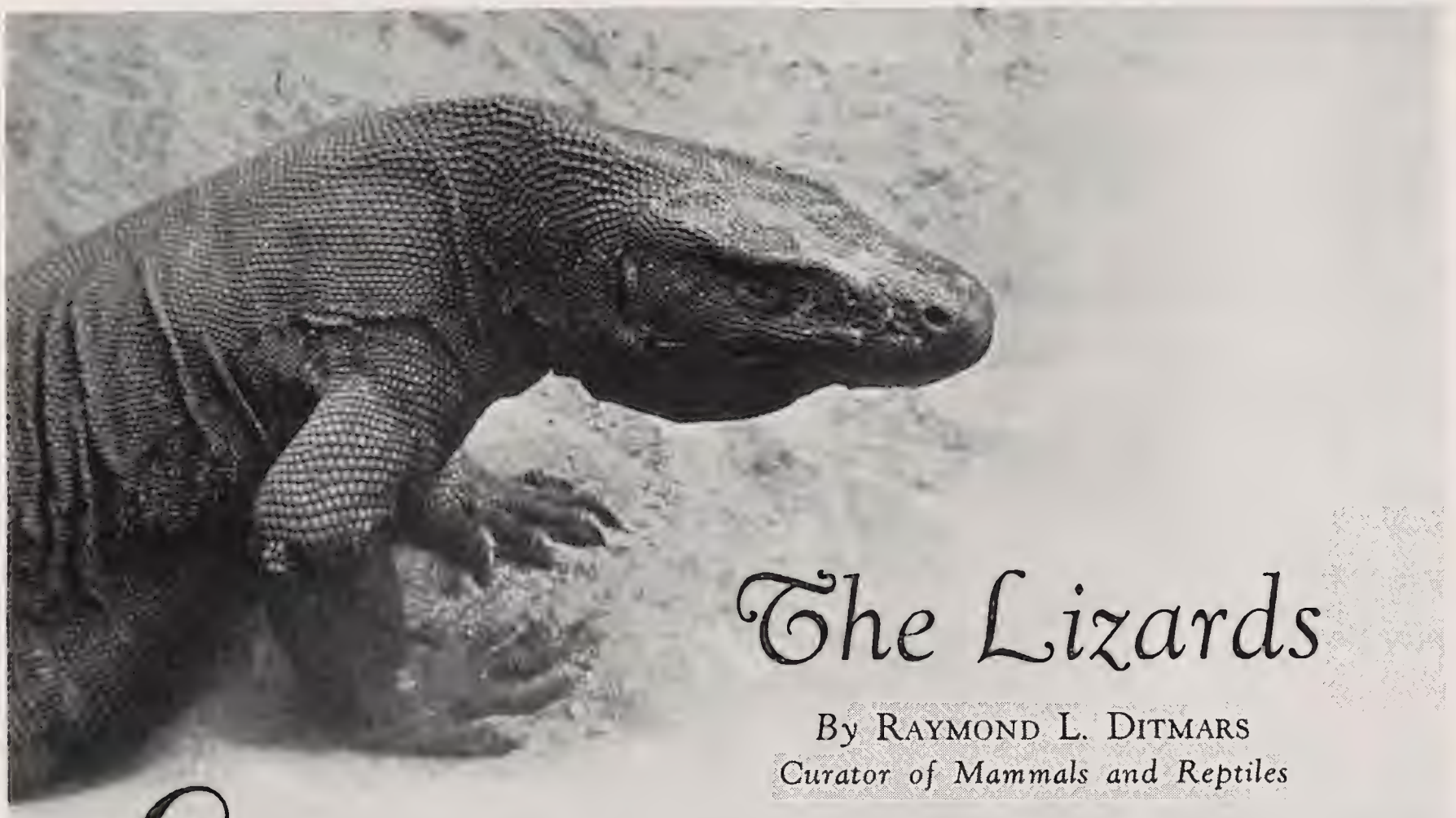
McGILL HONORS DR. BLAIR

AT the annual convocation of McGill University on May 30, 1928, the honorary degree of Doctor of Laws was conferred upon Dr. W. Reid Blair. Professor F. C. Harrison, in introducing Dr. Blair, presented him as "a distinguished graduate of McGill University veterinarian and pathologist; Professor of Comparative Pathology of N. Y. University; Director of the N. Y. Zoological Park, as Major in the 4th Army Corps of the American Expeditionary Forces; an author, excellent teacher and in his science a master mind who has devoted his life to the improvement of methods for the humane care and treatment of animals." *Ed.*



Allosaurus, a Giant "Lizard" (?) of the Age of Reptiles.

In spite of its name, which means "strange lizard," this huge extinct monster is neither a lizard nor an ancestor of the lizards. Nor are the modern lizards the degenerate descendants of any giants of the past. The facts are rather that both dinosaurs and lizards are descended from far older forms that lived soon after the great coal swamps were formed, and that these remote common ancestors were much more like lizards than dinosaurs in general appearance. The modern lizard may therefore be regarded as one of the oldest "living fossils." *From a painting by Charles R. Knight. Courtesy of The American Museum of Natural History.*



The Lizards

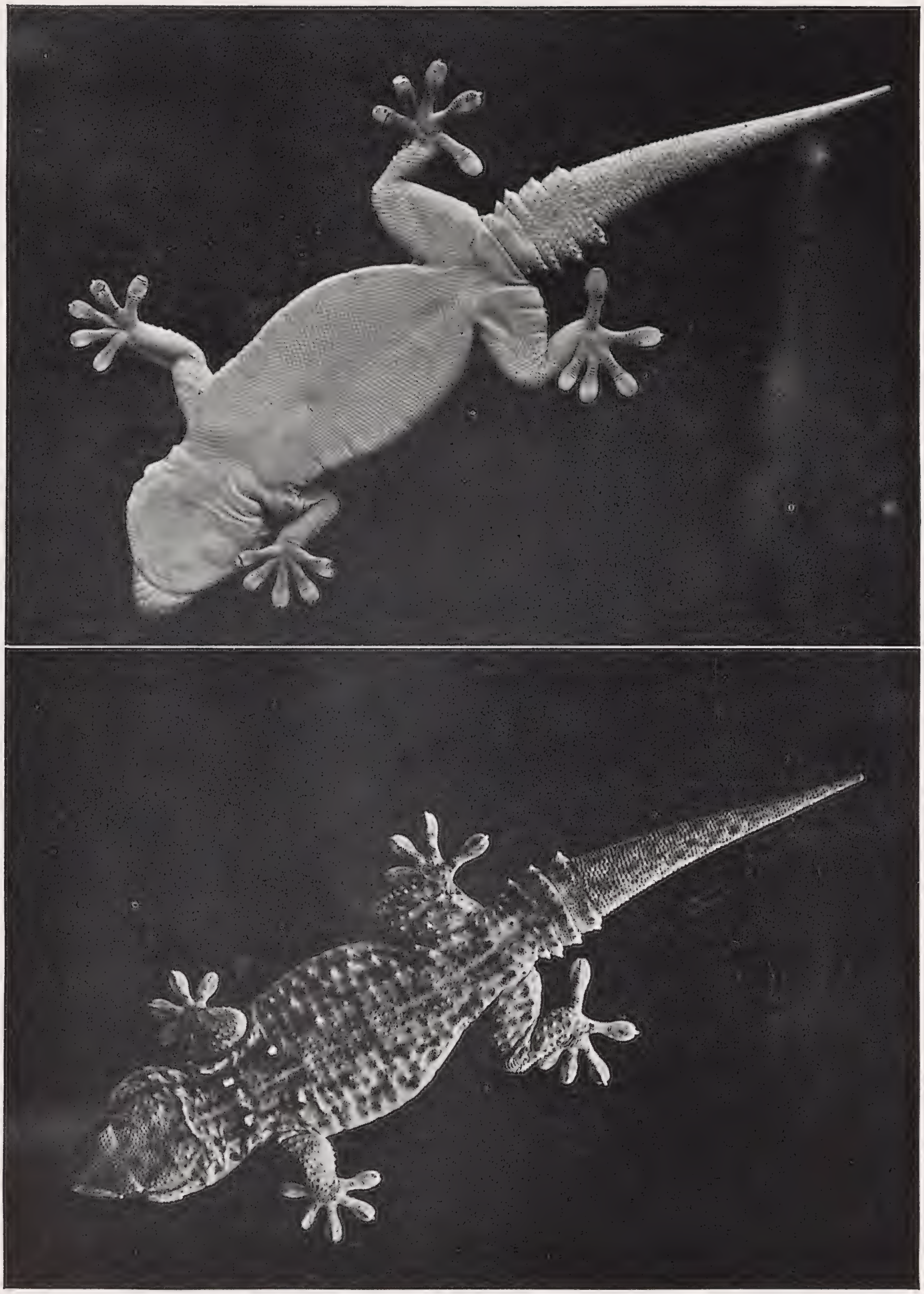
By Raymond L. Ditmars
Curator of Mammals and Reptiles

LIZARDS form the largest group among the reptiles. In systematic arrangement, they represent a suborder of the Squamata—the order of scaled reptiles made up of the lizards and the serpents. About 2,500 species are known. They range in size from diminutive forms to fairly large and powerful types like the monitors, and one species, the giant monitor of the Dutch East Indies, attains a length of over ten feet. Lizards are generally eclipsed in size by many species of their allied suborder—the snakes.

Again differing from the serpents, the members of the lizard suborder are essentially creatures of the tropical latitudes. North and south of the equator their species are abruptly thinned out in the warmer porions of the temperate zones, in latitudes where there is a great variety of serpent life. They disappear over the greater portion of the temperate zones having severe changes of the seasons, although an array of serpent species thrive over such areas and pass the winter in hibernation.

There are many more families of lizards than of snakes, and a far greater diversity of form. Their adaptation to various conditions constitutes a fascinating study. There are arboreal, ground-running, leaping and swimming types. A few are provided with dilatable planes and can make long, scaling leaps or "flights." There are also many burrowing forms. Many of the species are far more abundant than snakes.

Tooth structure is extremely varied yet among this great array of scaled reptiles, there are but two positively known to be poisonous. These are the beaded lizards (*Heloderma*) of the southwestern United States and Mexico, of which the Gila Monster is the most familiar example. A single species, *Lanthonotus,* of Borneo, is under suspicion, as it has grooved teeth.



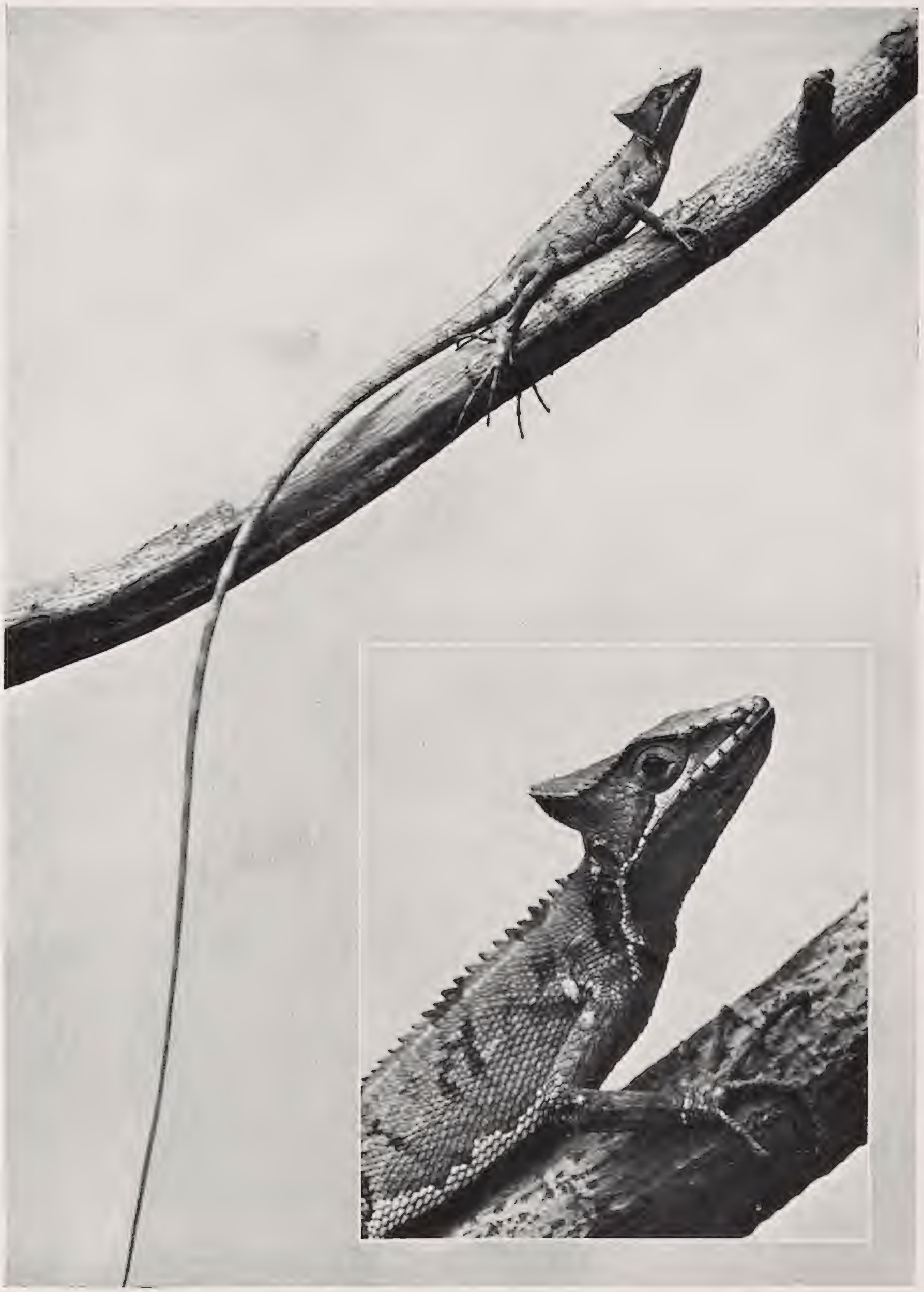
Ringed Gecko, *Tarentola annularis.* Northern Africa. The geckos form a large family and the greater number of species may be immediately distinguished from other lizards by their greatly dilated digits, the toes being expanded in the form of adhesive pads, the feet appearing from above somewhat like those of tree toads. The upper figure shows a specimen using the adhesive digits in walking on a vertical sheet of glass. These creatures can also run across a ceiling. Their scalation differs from most lizards in being extremely fine, or granular, and is often studded with tubercles, appearing like a toad's skin.



Mastigure, *Uromastix spinipes.* Egypt and Arabia. A desert species. It is a member of the extensive Old World family known as the *Agamidae.* This, and the equally large New World family, the *Iguanidae* are of particular interest in having developed phases of parallelism in gross similarity which include remarkably diversified types. *Lower*—American "Chameleon," *Anolis carolinensis.* Southeastern United States. Many species of these little lizards are distributed throughout the American tropics and the West Indies. They are noted for their quick changes in color. The true chameleons inhabit Africa, are unrelated and quite different from these types.



American "Chameleon," *Anolis carolinensis.* These attractive little creatures, varying from hues of brown to vivid green, are somewhat like the geckos in having expanded digits, which are adhesive and enable them to climb up smooth and vertical surfaces. This devolopment, however, is not nearly so pronounced as with the geckos. The males are distinct in having a dilatable fold of skin beneath the throat, which is frequently flashed during the mating season. This dewlap, as it is called, is a brilliant red with this species and yellow or various bright hues with other members of the genus.



Whip-tailed Lizard, *Laemanctus serratus.* Southern Mexico. This and the species on the following plate frequent the margins of lakes, and when frightened rush for the water, where they scamper along the surface on their hind feet, the elongated tail being reared as a balance. These lizards do not dive, but scamper along the top until they come to some protruding vegetation or derelict timber, under which they can hide. When running, the forelimbs are pressed against the sides.

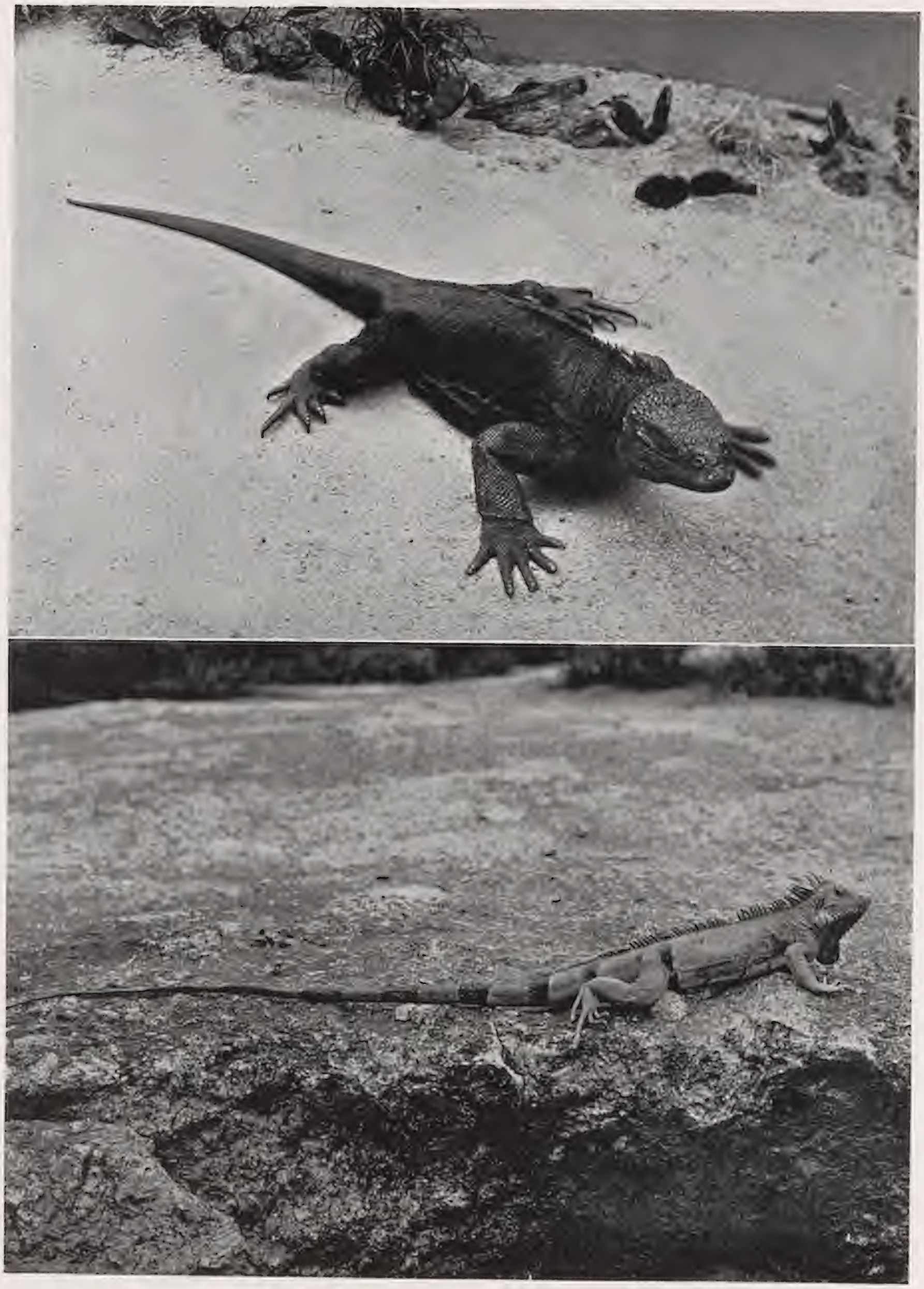


Striped Basilisk, *Basiliscus vittatus*. Southern Mexico and Central America. Speed is indicated in every outline of this lizard, which not only runs along the ground in rearing position on its powerful hind legs, but rushes for safety over the surfaces of ponds and lakes in the same manner. Lizards of this type are largely insectivorous, but vary their diet with small flowers and tender leaves. They are very abundant in Central America, but persistently haunt the neighborhood of sluggish streams, lakes and lagoons.



Land and Marine Iguanas, *Conolophus subcristatus* and *Amblyrhynchus cristatus.* Galapagos Islands. In the monotone of a photograph and without close-up details, the two species are not strongly distinct. Viewed at close range, they are quite different. One is brown and the other blackish. The heads are markedly different.

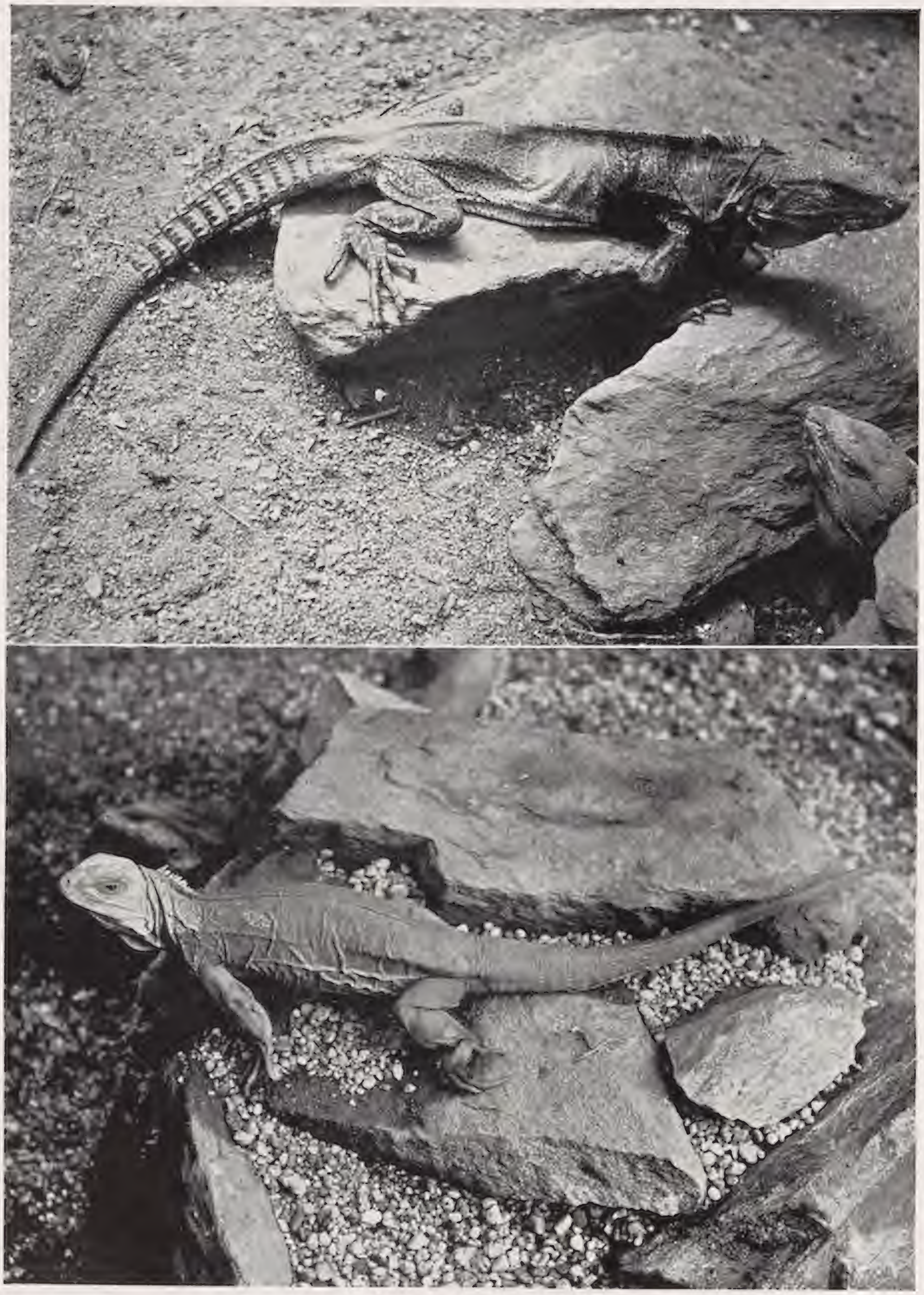
Lower—Marine Iguana, *Amblyrhynchus cristatus.* Galapagos Islands. No other species of truly marine lizard is known. These creatures live among the rocks washed by the sea and feed altogether upon sea-weeds. They cannot be kept alive in captivity as they refuse all food—including our native sea weeds.



Land Iguana, *Conolophus subcristatus.* Galapagos Islands. Quite different in habits from the marine species of the islands. While *Conolophus* is not of greater length (about four feet) from the allied type, it is much heavier, more active and very savage when restrained. It is of bright hues of brown and yellow. *Lower*—Common Iguana, *Iguana tuberculata.* Tropical America. Among the several species of iguana, this is the most widely distributed and generally abundant. It attains a length of seven feet and can deal severe blows with its lash-like tail. Throughout the American tropics it is highly esteemed as food.



Rhinoceros Iguana, *Metopoceros cornutus*. Haiti. There is a close rivalry between this species and the big land iguana of the Galapagos Islands as to size and bulk. It is a powerful, terrestrial animal and digs caves in the sand and coral slopes of the island. It is sometimes hunted with dogs and is a savage adversary. Dull brown in color, with wattles and protuberances upon the head, the sinister countenance surmounted by the rhinoceros-like horn, it recalls the restorations of prehistoric dinosaurs. It feeds commonly upon leaves and flowers, but will attack and devour small mammals and young birds.



Spine-tailed Iguana, *Ctenosaura acanthura*. Southern Mexico and Central America. Several species of this genus are abundant in sandy or rocky areas and prefer conditions of intense heat. They are extremely delicate as captives owing to the dampness of our temperate latitudes. Their tails are ringed with coarse, spiny scales. *Lower*—Turks Island Iguana, *Cyclura carinata*. Female specimen. With most of the iguanas, the females have a much less pronounced dorsal crest of spines. This may be noted by comparing this photograph with the figures on the preceding plate.



Turks Island Iguana, *Cyclura carinata.* There are several quite closely allied genera of iguanas. This species is characteristic to a small group of islands in the West Indies. Another is confined to the Bahamas and Cuba. Generic definition is externally indicated by arrangement of scalation of the head and the size and development of scales encircling the tail. This is one of the smaller species, attaining a length of about three feet. Like most of the iguanas, it is hunted and eaten by the natives. Its cooked flesh is white and tender and said to taste much like chicken.



Desert Iguana, *Dipsosaurus dorsalis.* Southwestern United States. Living in the hot wastes of the Arizona and New Mexico deserts, this little lizard appears to be a miniature of iguana allies. It feeds upon leaves, flowers and insects and when closely examined has a clearly indicated dorsal crest of enlarged scales. *Lower*—Collared Lizard. *Crotaphytus collaris.* Central and southwestern United States. Coloration is particularly attractive. The body hue is usually greenish, with yellow streaks or patches and a bold spotting over all, of white or lemon yellow. These hues are intensified on the neck, where there is a double collar.



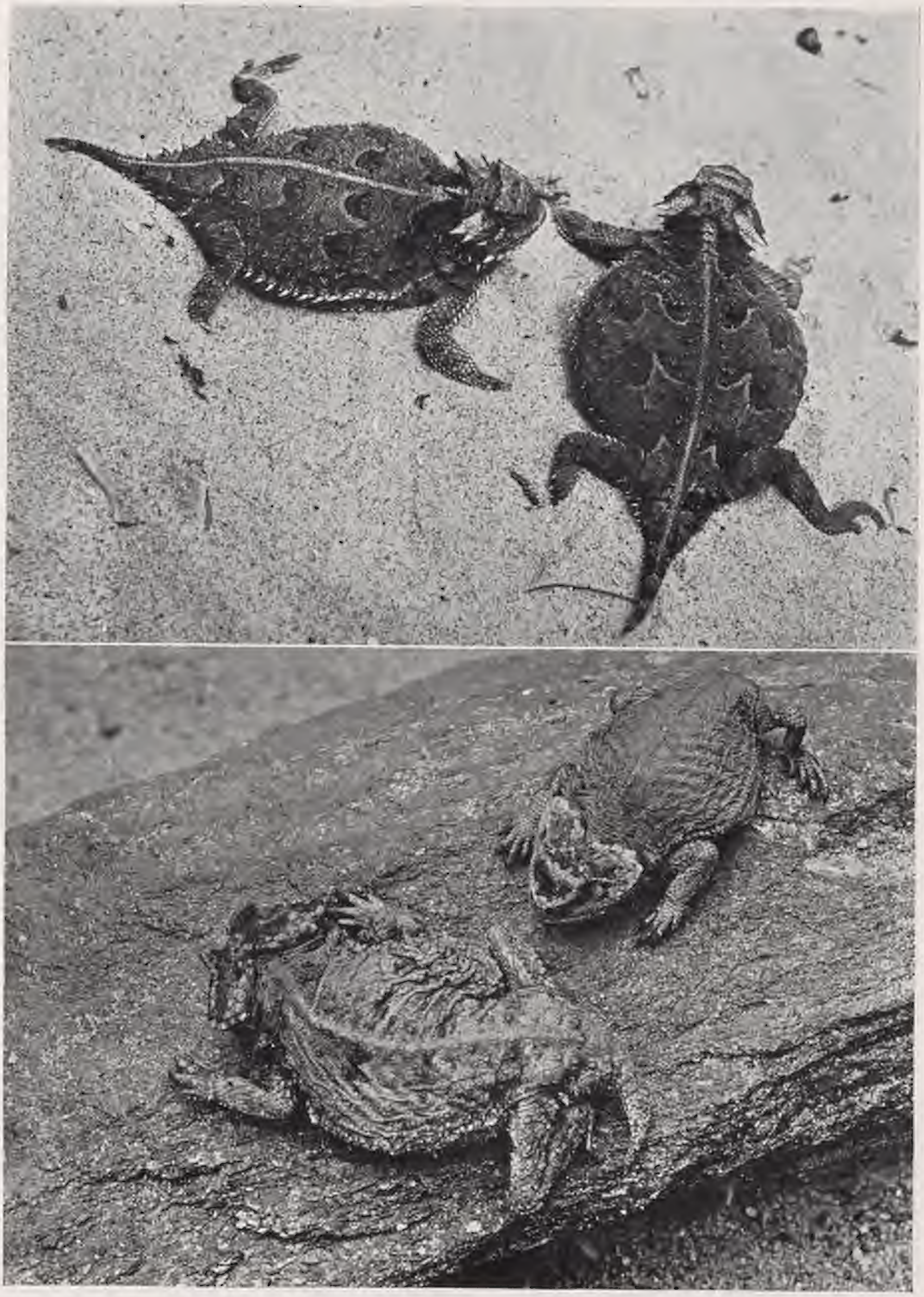
Chuckawalla, *Sauromalus ater.* Ancient lava and sand, under a burning heat form ideal home conditions for this iguana-like lizard of the southwestern United States. It feeds mostly upon desert vegetation and grows to the fair length of about twenty inches.

Lower—Leopard Lizard, *Callisaurus notatus.* Mohave Desert. There are no more agile creatures among all the reptiles that the lizards of the desert. They appear to skim over the ground and stop so abruptly the eye loses trace of them. Enlarged scales "feather" the toes for sand progression.



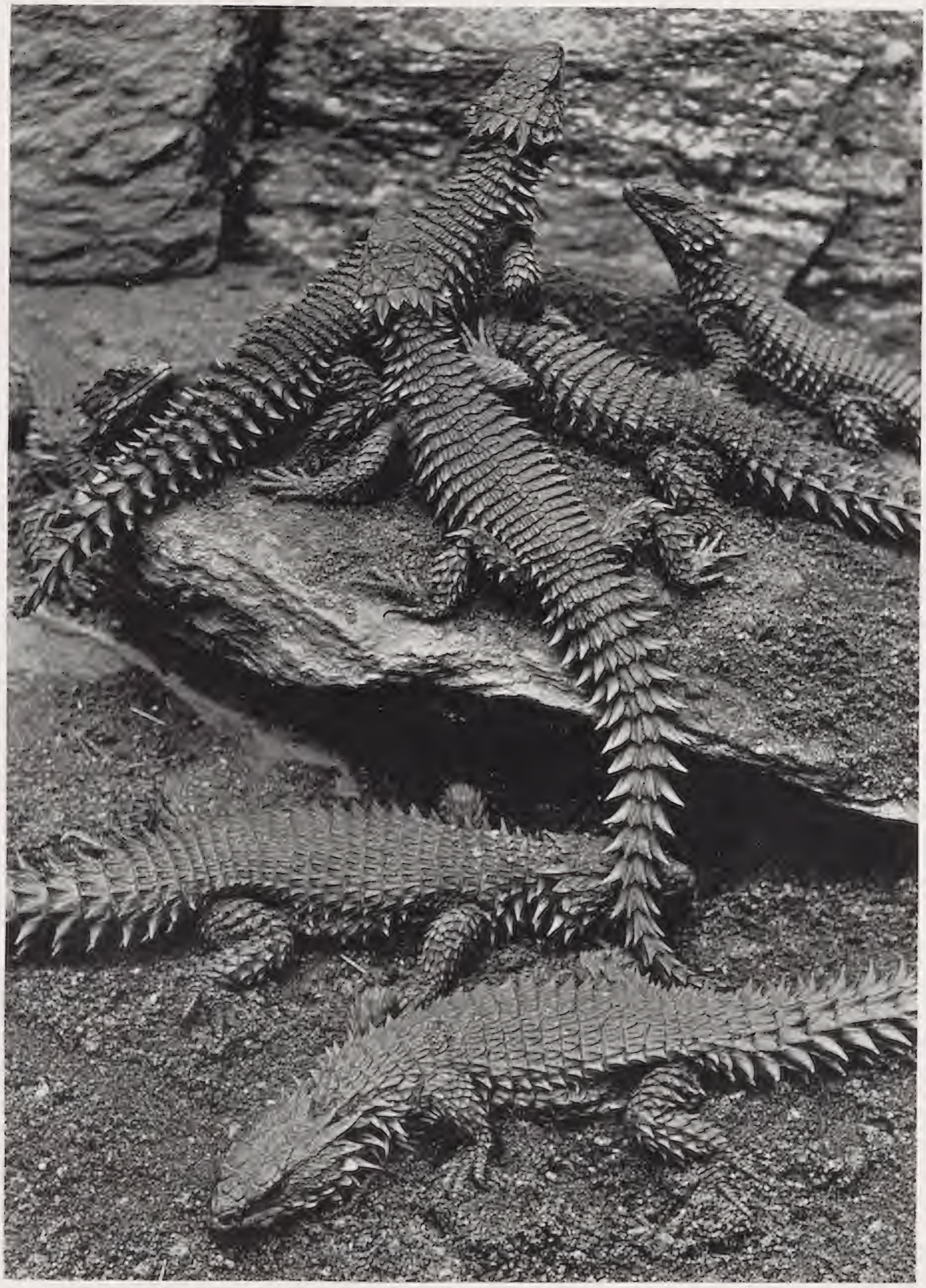
Fence Swift, *Sceloporus undulatus.* Eastern United States. Very abundant in our southern states and ranging well north of the eastern lizard area by occurring as far up as New Jersey. Its temerity in thus extending its habitat is exceeded, however, by the Blue-tailed Lizard—representing another family.

Lower—California Horned "Toad," *Phrynosoma coronatum.* Owing to the broad and flat body, these true lizards have long been called horned "toads." Fifteen species are recognized, of which the California and Texas species are the most familiar. They differ in the structure of horns and spiny scales of the body.



Texas Horned "Toad," *Phrynosoma cornutum.* Spiny covering of the body is not of so bristling a character as that of the California species. These creatures run swiftly and usually burrow into the sand at night. Their food consists largely of ants and other small insects.

Lower—Ditmars Horned "Toad," *Phrynosoma ditmarsi.* Region of the Mexican Boundary at Arizona and New Mexico. With this species the horns are reduced to rudiments, although the sides of the head are developed into projecting ridges. The body is rather smooth and particularly toad-like.



Spine-tailed Lizard, *Zonurus giganteus*. South Africa. Bristling with horny spines, this lizard would ordinarily appear to be quite well protected, but it is alleged to specifically employ its armament by crawling into its burrow head first, leaving the formidable tail to block the passage. A large specimen measures eighteen inches. It may also be classed as a desert type, as it lives in dry, sterile areas. It is interesting to note that the greater number of desert lizards have acquired enlarged, spiny scales, which is the tendency of many desert plants.



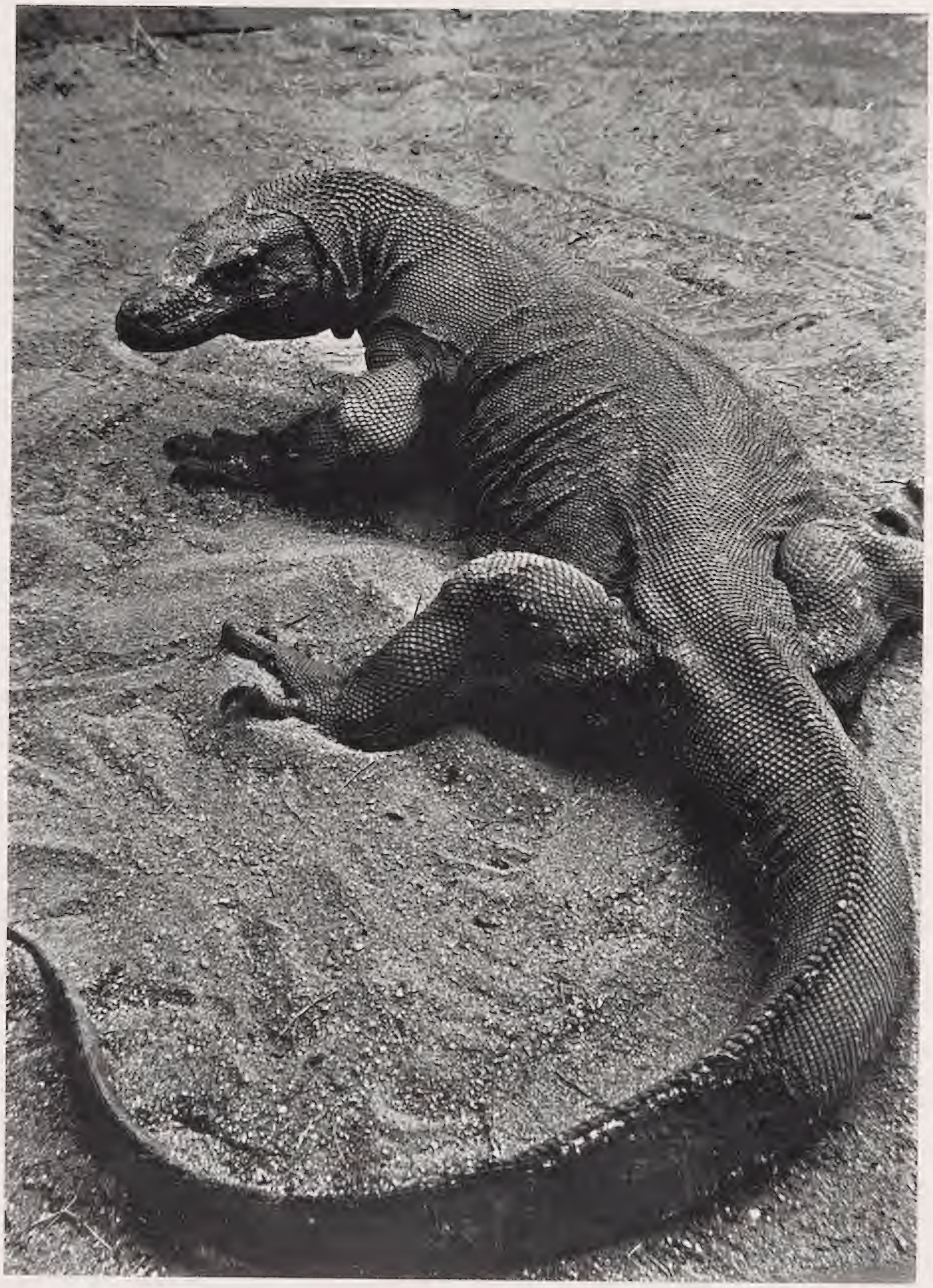
Glass "Snake," *Ophisaurus ventralis.* Southeastern United States. Commonly alleged to break into pieces which "crawl" together and form a reunited reptile. The tail is actually brittle and may be broken off in defense, the writhing of the broken section attracting the enemy's attention. It is replaced by a new member. *Lower*—European Glass "Snake," *Ophisaurus apus.* This true lizard and member of the family *Anguidae* is larger than the American species, attaining a length of three feet. The actual body forms about one-third its length. A pair of minute flaps at the vent are the vestiges of limbs.



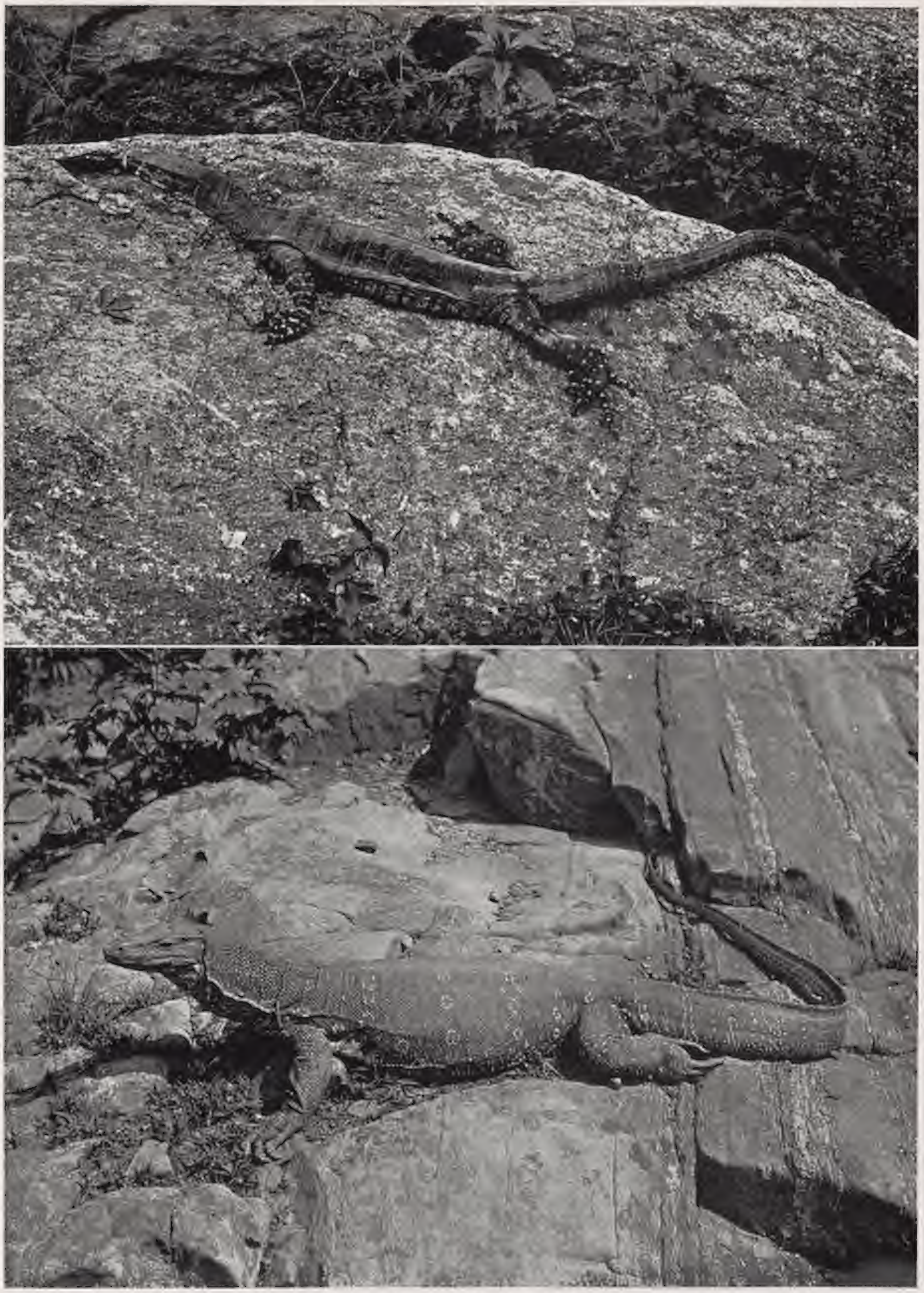
Alligator Lizard, *Gerrhonotus multicarinatus*. California. About six inches long and covered with square, leathery-looking scales, this lizard represents a curious family—the *Anguidae*. The members have bony plates beneath the scales; some have well-developed limbs and others are limbless, crawling like serpents and often being mistaken for snakes. Seven species of alligator lizards inhabit the western portion of the United States and northern Mexico. One hardy species ranges northward through western Washington and Oregon to Vancouver Island.



Beaded Lizards, *Heloderma.* Among the twenty-five hundred kinds of lizards, these are the only known poisonous species. They form the family *Helodermatidae,* containing a single genus with its two characteristic species. The larger figure is that of the Mexican Beaded Lizard. *Heloderma horridum. Lower*—Gila Monster, *Heloderma suspectum.* Habitat is defined as extreme southern Utah, and Nevada, Arizona and Sonora. Enlarged glands and grooved teeth in the lower jaw constitute the poison apparatus. The venom is similar to that of snakes, but much less virulent in its effects.



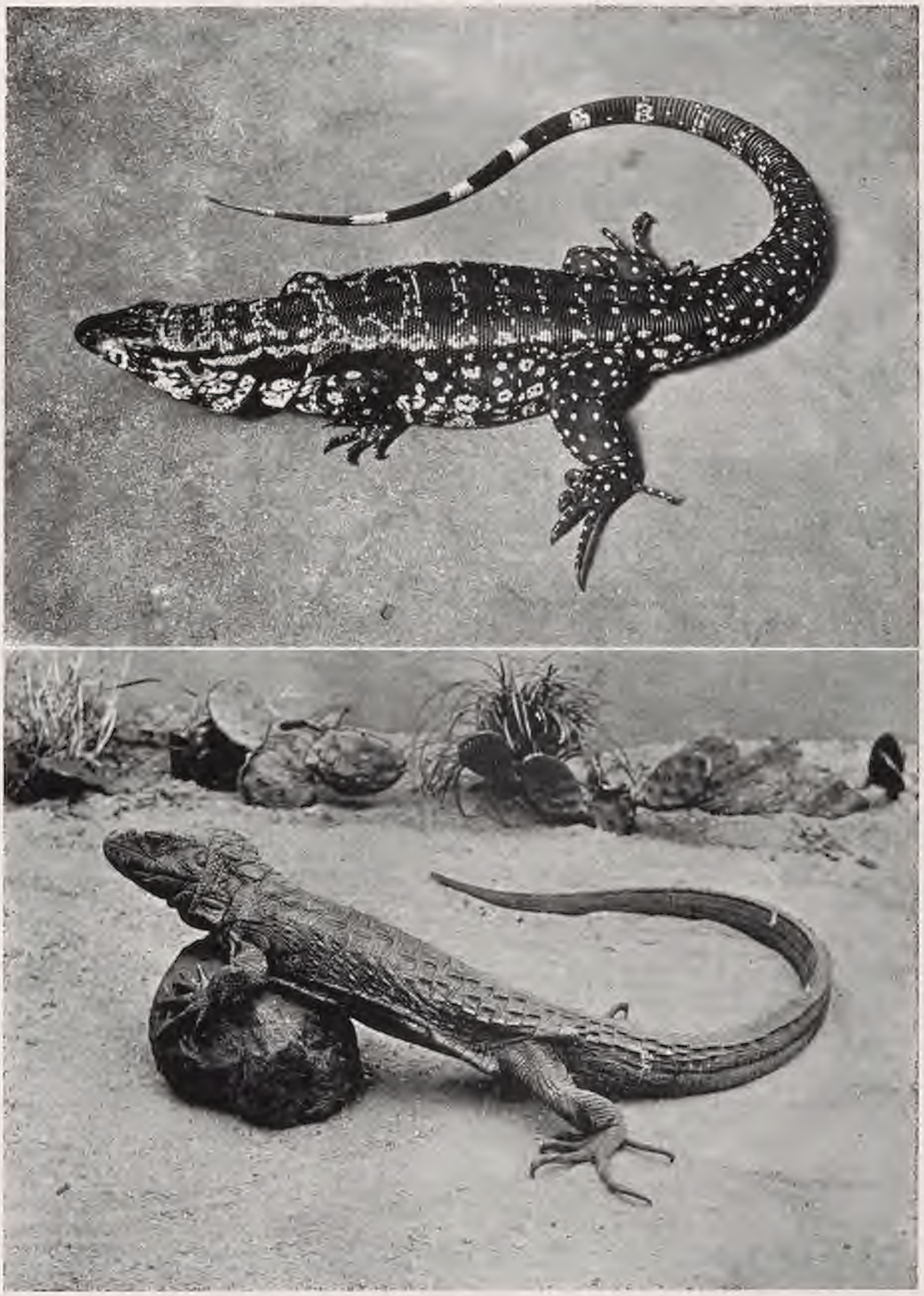
Giant Monitor, *Varanus komodoensis.* Island of Komodo and westerly portion of Flores, in the Dutch East Indies. Recently discovered, this powerful lizard astonished students of reptiles. It grows to a length of considerably over ten feet, and attains a weight of close to one hundred and fifty pounds. It is the largest existing species of lizard, although not greatly eclipsing the big Ceylonese Monitor, which, however, is of much lighter build. This and another living specimen were the first to be exhibited in the United States. They were collected by the Douglas Burden Expedition to the Island of Komodo in 1926.



Australian Monitor, *Varanus varius.* Thirty species of large, carnivorous lizards make up the monitor family, *Varanidae.* All are contained within a single genus. They range through northern Australia, the East Indies, China and eastern India. The Australian Monitor attains a length of about six feet. *Lower*—Ceylonese Monitor; Kabara-Goya, *Varanus salvator.* The actual range of this powerful lizard includes eastern India, Ceylon, China and Malaysia. It is the second largest species of lizard, attaining a length of close to ten feet. All of the monitors have a very long, forked tongue.



Common Tegu, *Tupinambis teguixin.* Guianas to Uruguay; West Indies. These distinct and powerful lizards are altogether carnivorous. They grow to be three feet long, are fleet and savage, pursue small reptiles, dig small mammals from their burrows and are destructive to poultry. This species represents the *Teiidae,* a New World family of forty-five genera and about one hundred and fifty species. The family contains the largest species of American lizards—the tegus or teguexins, and a great variety of smaller types, which resemble the Old World lizards of the family *Lacertidae,* but differ in structure of the teeth.



Black Tegu, *Tupinambis nigropunctatus.* Guianas and Brazil. A swift running and powerful lizard, with brilliant pattern of yellow on glossy black scales. The tegus are exceptionally hardy as captives. The specimen shown in the photograph lived in the Zoological Park for over ten years.

Lower—Alligator Tegu, *Dracaena guianensis.* Guianas and Basin of the Amazon. Its form is similar to the species of *Tupinambis,* but the large, leathery scales of the back and tail give it an alligator-like aspect. It is delicate as a captive and refuses all food but snails.

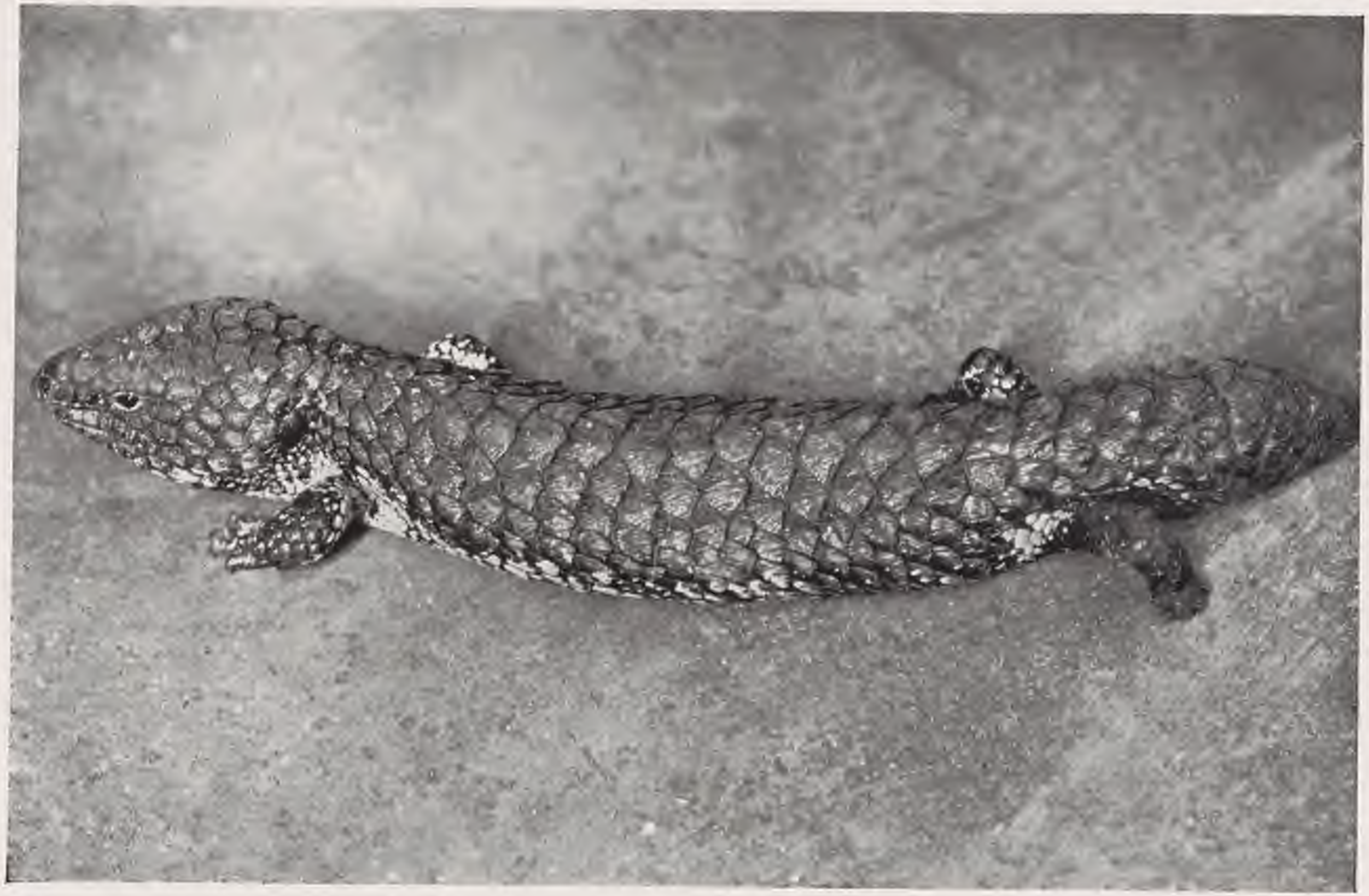


Alligator Tegu, *Dracaena guianensis*. Guianas and Basin of the Amazon. The coarse and irregular scalation presents an interesting study in Mr. Sanborn's particularly fine photograph. The larger scales are heavily keeled and separated by rows of smaller scales. Those of the limbs are small and regular; on the top of the head are large and smooth. It is by such definition that lizards are separated and identified in the scientific or systematic value. Among the smaller and more monotonous species, where there are many in a genus, the identification of occasional specimens may be quite difficult and time consuming.

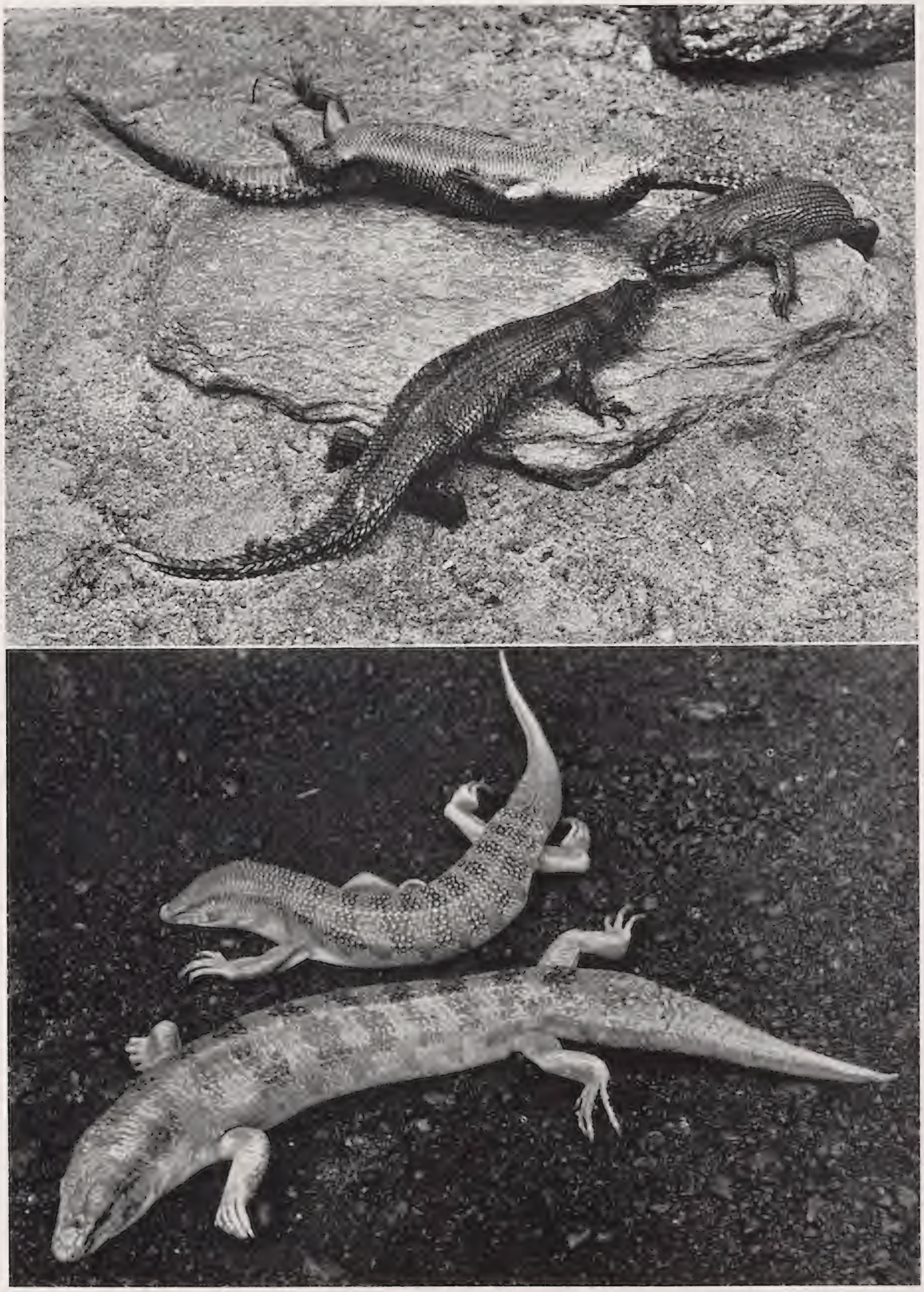


Green Lizard, *Lacerta viridis*. Central and southern Europe; southwestern Asia. Here is a typical lizard in all that the name implies. It is of moderate size, without eccentric development of scalation or body contour. Allied species of this type are abundant in central and southern Europe.

Lower—Sand Lizard, *Lacerta agilis*. Europe and western Asia. A typical member of the *Lacertidae*. This and allied species are the only lizards found in the British Isles. It seldom exceeds a length of six inches. It is said to be the only reptile in Ireland, although there have been reports of occasional grass snakes.



Stump-tailed Skink, *Trachysaurus rugosus*. There is little difference in outline between tail and head. The rough scalation suggests a pine tree cone. Extremely erratic forms like this are rather unusual among the skinks, which, in scalation and form are not given to decorative or very unusual development. Their various lengths of limb, however, bring the family in prominence, as these range from strong running members to diminutive and weak, or quite useless appendages. Lizards of the latter type glide like serpents and most of them lead a semi-burrowing life.



Cunningham's Skink, *Egernia cunninghami.* Australia. The skinks form a great cosmopolitan family, with the greater number, however, occurring in Africa, Asia and Australia. One of the specimens in this photograph is feigning death, a habit of this species that is occasionally indicated during handling. *Lower*—Sand Skink; Sand "Fish," *Scincus officinalis.* The Sahara. Close examination of this creature shows marked modification for a life in powdery, desert sand. The snout is sharp and used as a burrow-wedge, while a fringe of scales on the toes enables it to walk without sinking.



Common Chameleon *Chamaeleon vulgaris.* There are more than fifty distinct kinds of chameleons. They are the most highly specialized among the lizards, possessing a prehensile tail, while the fingers and toes have become fused as opposable clasps to form perfect grasping organs. The eyes are remarkable in being large, rolling members, covered by tough skin, with a small opening in the center for the pupil. The eyes roll independently. The sixty species form a distinct family inhabiting Africa, the shores of the Mediterranean and India. These lizards are noted for their remarkable changes of color.

VOL. XXXI, NO. 5 SEPT-OCT, 1928

BULLETIN
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A PUBLIC ZOOLOGICAL PARK · A PUBLIC AQUARIUM · THE PRESERVATION OF OUR NATIVE ANIMALS · THE PROMOTION OF ZOOLOGY

VOL. XXXI, No. 5 SEPTEMBER-OCTOBER, 1928

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A typical landscape in the Galapagos Islands. The entire dark mass is lava rock, dark brown in color, the outpourings of countless ages of volcanic disturbances. The surface, seamed and cracked, is covered with countless sharp edges which only the strongest footgear could withstand. Progression over this terrible surface is accomplished with the greatest difficulty, and, as though to demonstrate more thoroughly the fearful forces of nature in this formidable place, a tangled mass of wiry plants and thorny shrubs, almost impassable, filled every crevice. In this gloomy place the morbid genius of Dante and Dore would have found a delightful field for imaginative contemplation.

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Published by the New York Zoological Society

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CONSERVATION OF WILD LIFE

By MADISON GRANT

President of the New York Zoological Society

ONE of the three objects of the Zoological Society, as expressed in its charter, is the conservation of wild life. Constant appeals for help reach the Society from all over the world, as for example from Australia to save the marsupials threatened with extermination by fur hunters; from South Africa to protect the few remaining white rhinoceros of Natal by transferring them to the new Kruger Game Preserve; from our Pacific coast to prevent the wanton slaughter of seals and sea lions at the behest of the commercial fishermen. To all these requests for aid, the Society is responding to the best of its limited resources by subsidizing local agencies of conservation. Not content with this, the Soiety has recently undertaken a unique and highly successful enterprise of its own.

The Giant Land Tortoises of the Galapagos Islands, which lie 500 miles off the coast of Ecuador, are verging on extermination, due primarily to the killing of thousands by the crews of passing ships over a period of three centuries; secondly, to an Ecuadorian oil industry which killed off large numbers of the tortoises remaining in the interior of the larger islands; and thirdly, to the introduction of dogs, pigs, cats and rats on the islands, which having run wild, destroy the eggs and the young. The tortoises have become entirely extinct on the smaller islands and recent expeditions report that they had apparently vanished on all the larger islands.

The Society authorized Dr. Charles H. Townsend, Director of the New York Aquarium, to visit the islands with a special ship and to locate, if possible, any survivors of the tortoises that might be found in the almost inaccessible interiors. Dr. Townsend was preeminently qualified for this task, because he had already made two visits to the Galapagos in years past and had collected most of the species of birds and reptiles there, many of which at that time, were new to science.

The expedition was a brilliant success and Dr. Townsend, owing to his knowledge of local conditions and to his skill as collector, secured no less than 180 tortoises at Albemarle Island.

Of great interest to the Executive Committee was the fact that Dr. Townsend kept within his allowance for expenses, a fact almost unique in collecting expeditions. This would of course have been extremely difficult without the fortunate cooperation of the United States Bureau of Fisheries. When the matter was presented by the Director to Hon. Henry O'Malley, Commissioner of Fisheries, one of the vessels of the Bureau was made available for the expedition. It happened that the steamer *Albatross II* was about to be laid up for a couple of months, awaiting an appropriation. The Zoological Society offering to assume the cost of operation, the vessel was sent to the Panama Canal where she was joined by the Director and his party of three. Coal and supplies being on board, the *Albatross II* sailed from Balboa, Canal Zone, on March 30th for the Galapagos. Through the

excellent service of this vessel the original program was carried out with little variation, her master G. W. Carlson, making the whole run of more than 1,600 miles without concern on account of coal, freshwater or supplies. The *Albatross II* returned to Balboa on April 22d, the object of the expedition having been achieved in record time and to a most satisfactory degree.

The Society is obliged to rely on the generosity of its Managers for the necessary funds for this and similar expeditions, and the Executive Committee takes this occasion to acknowledge the following subscriptions:

Robert S. Brewster	$1,000
Bayard Dominick	1,000
Anson W. Hard	1,000
Anthony R. Kuser	1,000
Irving K. Taylor	1,000
Henry D. Whiton	1,000
Total	$6,000

This Bulletin is devoted to the account of the capture of these tortoises and the planting of seven colonies in locations where it is believed they will thrive and multiply.



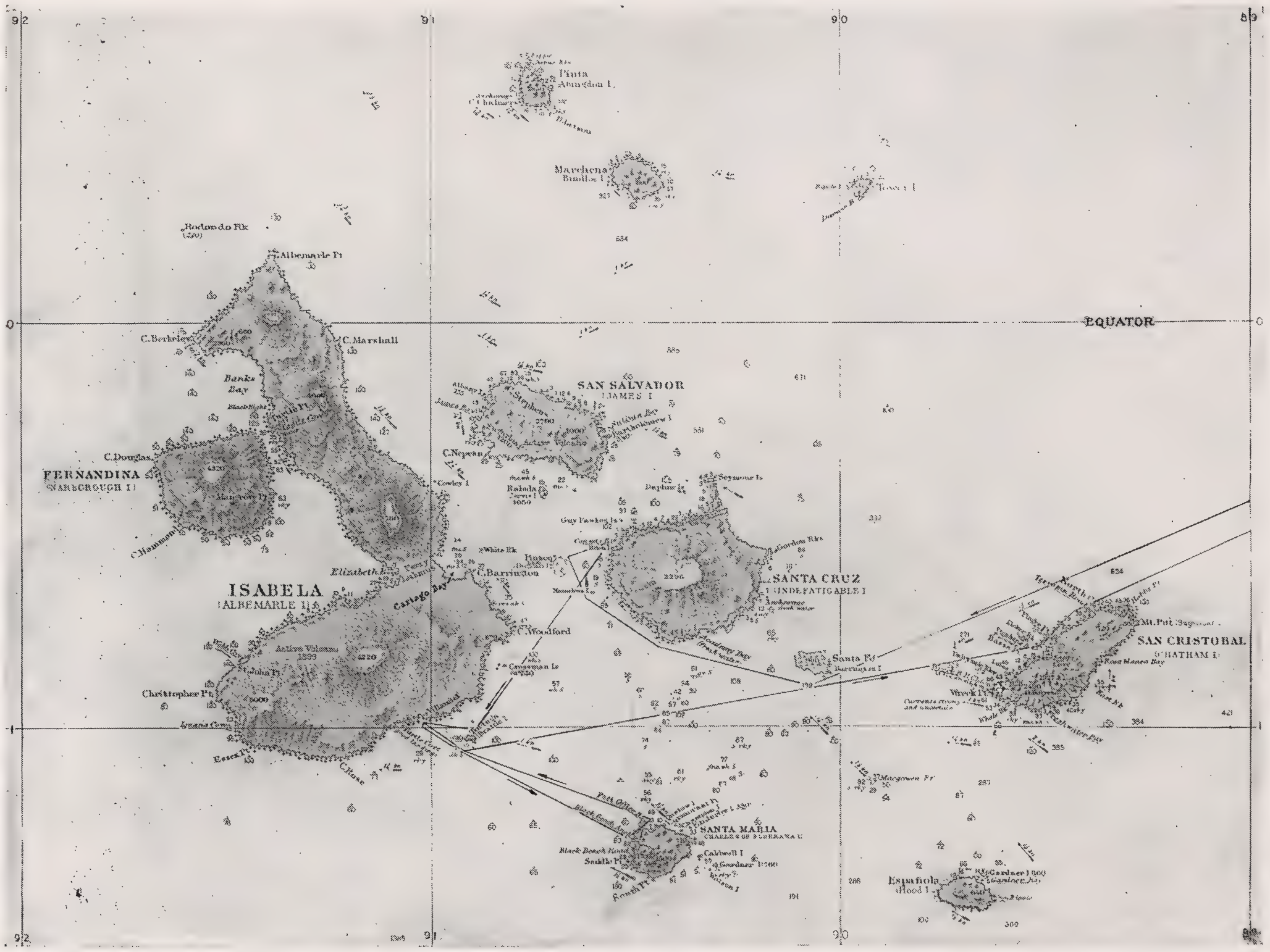
The U. S. Bureau of Fisheries Steamer *Albatross* II at anchor off Albemarle Island, Galapagos Archipelago.

THE GALAPAGOS ISLANDS REVISITED

By CHARLES HASKINS TOWNSEND

THERE are few definite solutions to the problems presented to naturalists by the Galapagos Islands. Their origin and that of the animals and plants inhabiting them remain largely in the field of speculation. Being wholly volcanic the origin of the islands is the simpler problem. Among geologists there is usually agreement that the islands appeared not earlier than Tertiary times. Volcanic activity continues on two of them. The coral formations about their shores are of later development, inconspicuous and of limited extent.

Lying on the Equator 500 miles from the nearest part of the mainland, the source of their terrestrial organisms is more conjectural. Naturalists are not disposed to claim that their forms of life originated there but



Map of the Galapagos Archipelago, showing the route of the Expedition. The arrows along the lines indicate the directions sailed and the various anchorages. Taken from a chart made by the U. S. Bureau of Hydrographic Survey.

rather developed through long isolation from forms originating elsewhere. It has been assumed by some that the many islands are the remnants of a larger oceanic area the most of which has disappeared through subsidence. However, this may be, the peculiar organisms of each island have relationships with those of the others. Both animals and plants have affinities with forms inhabiting the mainland. Their introduction presents the chief problem.

The forms existing there have apparently not changed since the discovery of the islands in the 16th Century, except as influenced by man and the domestic animals introduced by him.

The theory of a former land connection with the American continent finds little favor at the present time. The intervening ocean depths are very great. The islands are of considerable area and elevation, while the variety of living forms is decidedly limited. A former land bridge should have provided them with vastly greater numbers of both animals and plants.

Vertebrates are represented only by birds and reptiles and these by very few genera. The species of these are the result of long insular separation. There are no native mammals except bats. While insects and plants are better represented, their limited variety offers small support to the theory of a former land connection with the zoological and botanical riches of the Americas. The birds and bats are not very difficult to account for. Cocos and Malpelo Islands might have served as half-way stations for some of them and both of these islands may have been larger in former times as the soundings about them indicate.

Some of the problems of the Galapagos are probably not as difficult of solution as has



A landing place on the shore of Duncan Island. The long, sharp, rocky eminence is a mass of ancient lava which had precipitated itself into the sea. The water deepened abruptly at its base, swirling with every tide around the fragments of lava boulders which had broken from the parent flow.

been supposed. Their solution appears to lie in such natural agencies of distribution as currents and winds. There is also the possibility, in the case of tortoises, of the influence of aborigines. The Galapagos Islands extend through more than two degrees of latitude and of longitude. They lie in the course of two currents setting toward them from the mainland. In three voyages there we have observed floatsam that must have originated in the rivers of Central and South America. The prevailing winds are also in the direction of the islands.

The ancestor of the peculiar Galapagos penguin which is related to the Chilian penguin, must have arrived through the agency of the northward flowing Antarctic current. No such ready explanation can be offered for the flightless cormorant with its abortive wings. It has less wing power than a penguin and has no counterpart elsewhere.

Lying in comparatively calm seas, it is conceivable that castaway aborigines drifted there. Primitive peoples have made voyages quite as long in Polynesia. The existence of the islands being discovered involuntarily, intentional voyages might have followed. Of such there are, however, no traces. The wide distribution of sea turtles in equatorial waters should not be overlooked as a possible source of food for primitive voyagers.

The desert-like coastal portions of the islands are not inviting and water is not easily found. Greater volcanic activity in earlier times may have served as a deterrent to aboriginal colonists. Most of the islands are dotted with old craters large and small. The indigenous plants offer little in the way of food. There are no cocoanut trees except a dozen or two introduced on Albemarle Island. A single voyage with tortoises might explain the presence of such important food animals when the islands became known to civilized man in the 16th Century. It would not be a very wild guess that tortoises were taken to the Galapagos Islands by primitive man. Speculation regarding such matters is interesting however inconclusive it may be.

The point of greatest interest in connection with the Galapagos Islands is the existence of



A view across the lower crater on Duncan Island. The rim of the crater on the western side is indicated by the figure in the foreground and the eastern rim is directly opposite, a distance of about three-quarters of a mile. The descent into this crater was a heartbreaking task, impeded at every step by shifting lava boulders and tangled, wiry, whip-like shrubs. The floor of the crater was as formidable as the sides; it supported on its desolate surface a sparse, tough grass and a maze of growth that could not be designated as either trees or shrubs; and it was so dry and porous that if a deluge of rain had swept down upon it, the soil would have instantly engulfed the torrent and there would have been left no signs of its occurrence.

land tortoises of prodigious size, and formerly, in amazing numbers. Dampier who visited the Galapagos in 1684 says of the tortoises: "it is incredible to report how numerous they are." Similar affirmations regarding their abundance are to be found in the accounts of the early navigators who followed him. It was this outstanding feature that gave the Galapagos* Islands their name. It was the abundance of tortoises that attracted food-seeking ships for more than three centuries, an attraction that persisted until the exhaustion of the supply.

With the wondrous tide of tortoise life brought to a low ebb in the 19th Century by man, there followed no rise when he withdrew. The pests he had introduced proved sufficient to prevent any increase among the scattered survivors. Dogs, pigs, cats, and rats abandoned there, returned to the feral state and increased to thousands. The eggs and newly hatched young of the tortoises became their food, few escaping. The adults wearing their shell armour were largely immune. Then followed the Ecuadorians who killed tortoises assiduously for their oil. The animals have long been extinct on eight of the islands where they once swarmed. Wild dogs and other predatory pests roam in thousands on the two large islands where limited numbers of adult tortoises are still to be found—mostly far inland.

Tortoises are still hunted occasionally by natives of the two small settlements remaining on the Galapagos. Their continued existence on Albemarle and Indefatigable islands cannot be hoped for.

With these facts under consideration the Board of Managers of the New York Zoological Society, authorized the writer to procure if possible a breeding stock of tortoises for colonization in our southern states under favorable climatic conditions. With the cooperation of the U. S. Bureau of Fisheries, the

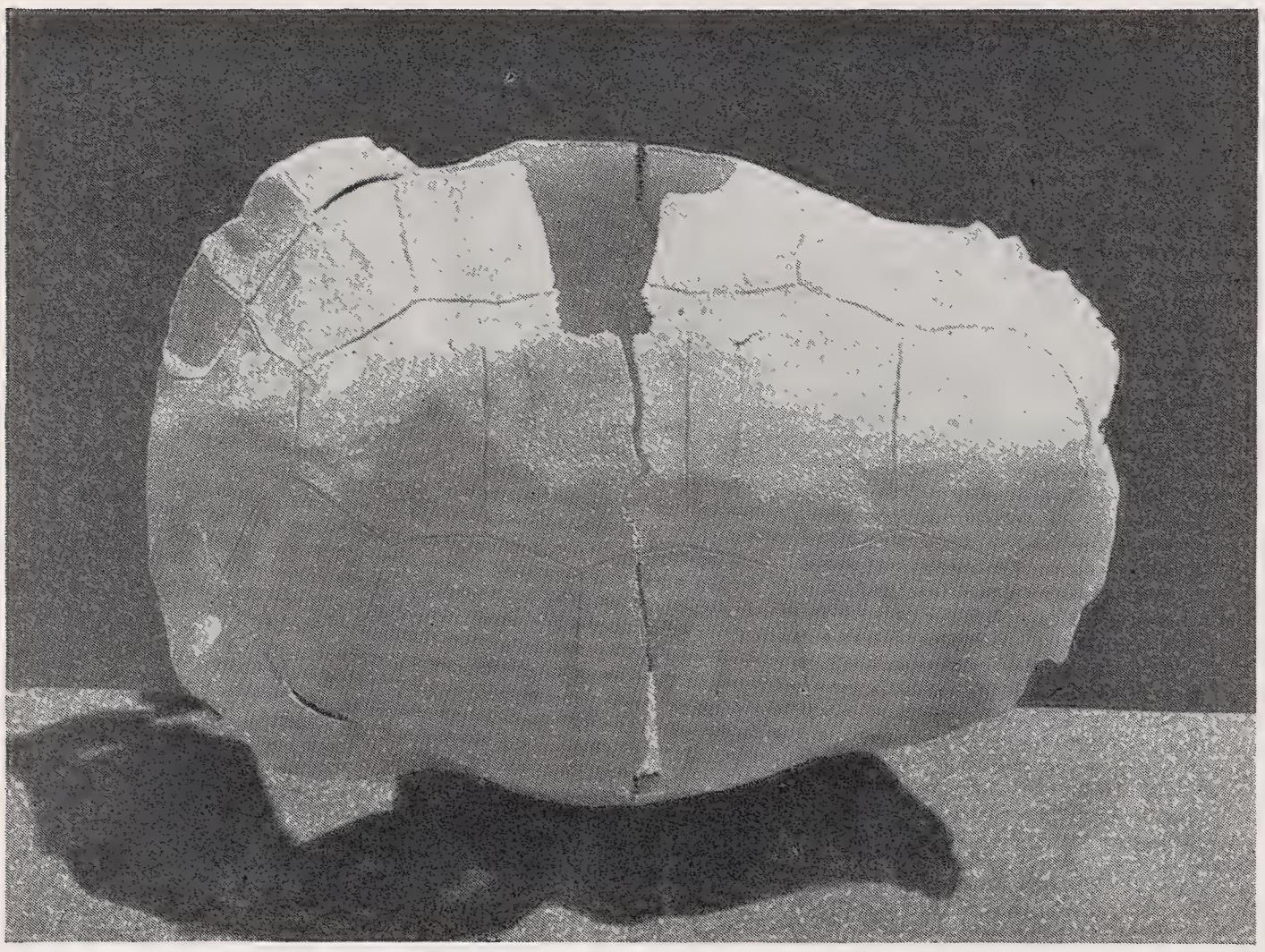
* Spanish tortoise.



Landing on Duncan Island or any lee shore in the Galapagos was fraught with hazards. The restless seas swept over submerged reefs, riding a skiff high and swiftly toward the shore and then as they retreated it required fast and accurate work for the oarsman to put one passenger ashore. Time and tide were not sociable and they awaited no man in the Galapagos.



The eastern rim of the lower crater on Duncan Island. The character of the surface and some of the vegetation are pictured rather graphically. This is a particularly open space and when a spot like it appeared the foot-weary explorers regarded it with delight; it is an easy piece of walking. The boulders were covered with indentations whose glass-like edges cut into shoe leather like a knife, and when the boulders rolled under foot as they frequently did, contact with these sharp excresences was a painful experience.



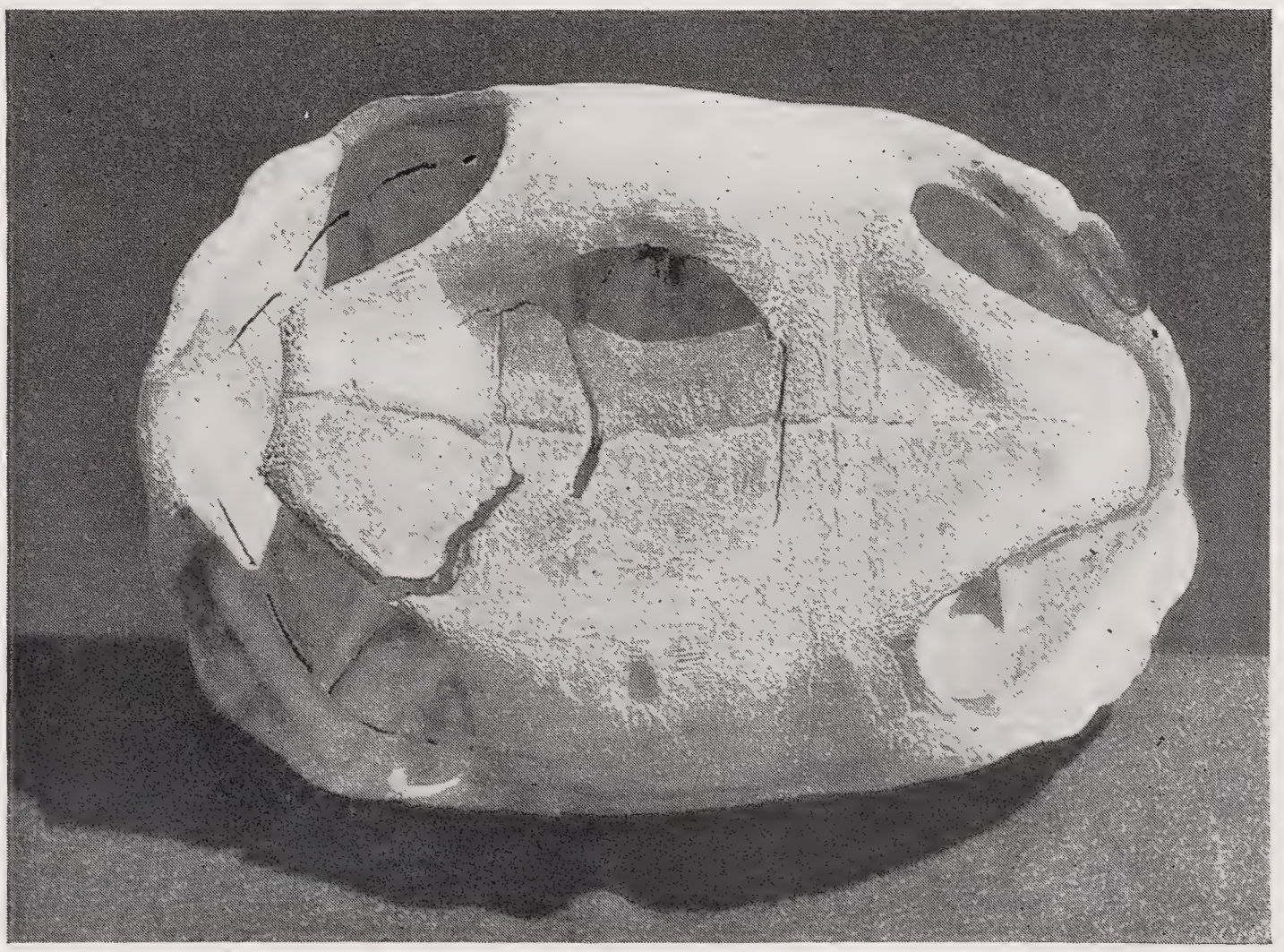
Carapace of extinct tortoise (*Testudo galapagoensis*) of Charles Island. Galapagos Archipelago.

steamer *Albatross II* was sent to the Galapagos in March, 1928,* under my direction.

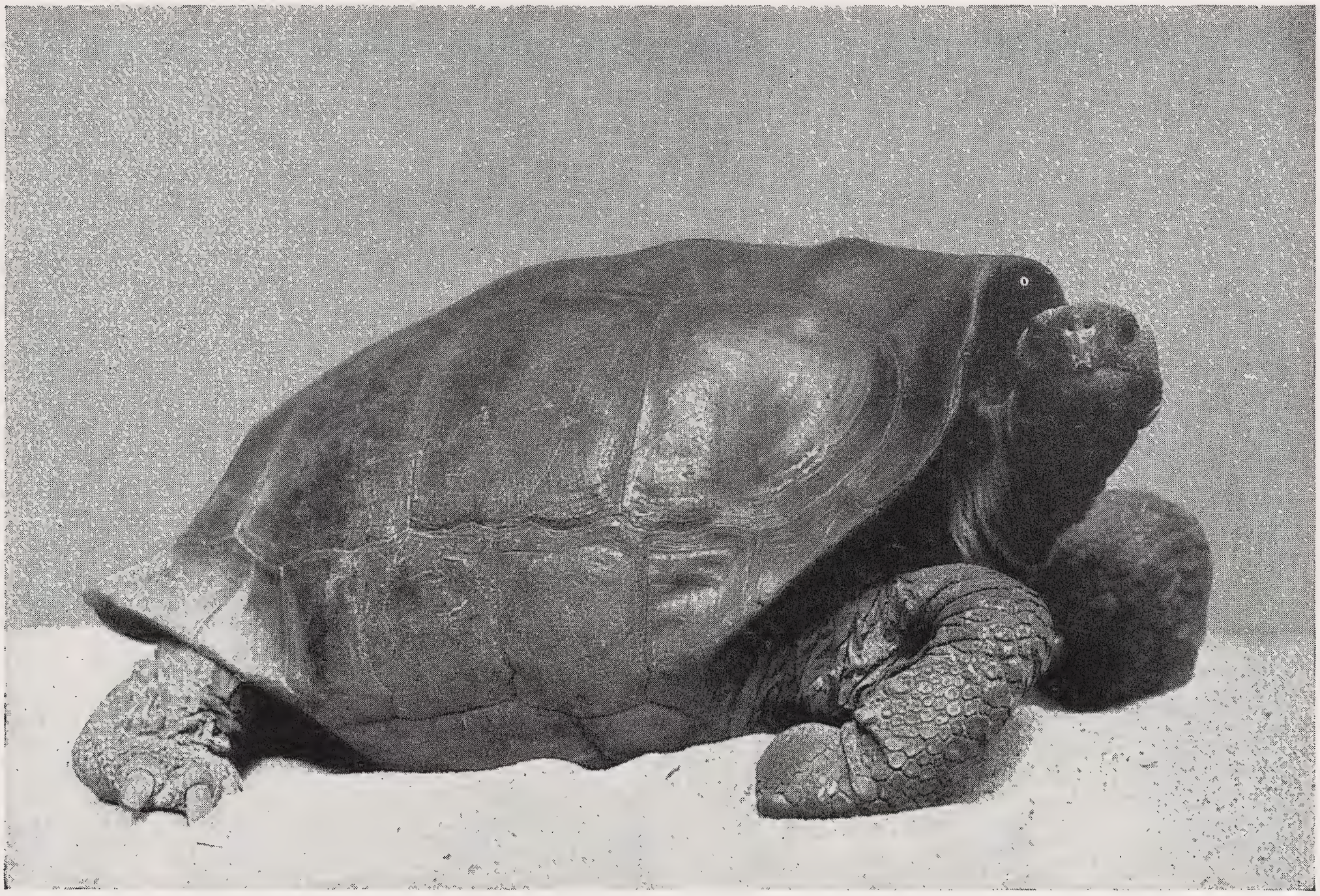
The success of the expedition greatly exceeded our expectations. A hundred and eighty tortoises were captured in the mountains of southern Albemarle which involved a week's journey with pack animals. We engaged twenty native Ecuadorians at the village of Villamiel, who with their burros, made an effective collecting party. Our interpreter, De Sola, rendered useful service in our dealings with these Spanish-speaking people. Twenty-five of the tortoises are established behind fences at the Botanical Gardens in the Panama Canal Zone with the official sanction of Governor Walker. Another lot of thirty is in the keeping of the San Diego Zoological Society. Twenty are located at the Boyce Thompson Southwestern Arboretum at Superior, Arizona. Colonies of fifteen each are in the zoological gardens of San Antonio and Houston, Texas, and New Orleans, Louisiana. A colony of ten tortoises is in the grounds of the Aquarium in Bermuda. These institutions cooperating with the New York Zoological Society have allotted space varying from half an acre to five acres as breeding ranges. All colonies are closely fenced with wire and are provided with shelters to which the tortoises can retreat during chilly weather or periods of unusual dampness. The remaining fifty tortoises will be located in southern Florida and elsewhere under safe climatic conditions.

The few Galapagos tortoises in northern zoological gardens have never been located

* My associates on this voyage were Elwin R. Sanborn, photographer for the expedition, Ralph DeSola, interpreter, of New York; and H. L. Gaddis of Detroit, all members of the Zoological Society. Capt. G. W. Carlson of the U. S. Bureau of Fisheries was in charge of the *Albatross II.*



Plastron of extinct tortoise (*Testudo galapagoensis*) of Charles Island. Galapagos Archipelago.



Duncan Island tortoise captured by Wm. K. Vanderbilt and presented by him to the Zoological Park. The outline of the shell of this species is horizontal anteriorly with declivity at the rear. The species—Albemarle Island—collected by the Townsend expedition show declivity at both the front and rear. Photograph made in the Zoological Park by E. R. Osterndorff.

under conditions favorable to reproduction either in this country or in Europe.

The great tortoise of Aldabra Island in the Indian Ocean has a history similar to that of the Galapagos tortoise. It was used for food by mariners for more than three centuries, when threatened with extermination, its propagation was undertaken under the auspices of the British Government. Distributed among the farmers of the adjacent islands of the Seychelles, it was domesticated and soon became a valuable food animal. The New York Zoological Society is hopeful of similar success with its congener of the Galapagos.

While a distinct species of tortoise has been recognized on each island of the Galapagos group, five have been described from the large island of Albemarle, which is probably too many.

Each tortoise in the colonies established by the Zoological Society has been given a number and has been measured and weighed. These records will be continued annually for a series of years until the rate of growth, and change with age are determined. In this way one of the problems of the Galapagos may be advanced toward solution, and some of the present confusion respecting species eliminated.

We are assured by natives of Albemarle that tortoises of large size are still to be found in the high interior of Indefatigable, an island having a diameter of about twenty-five miles. This island is one of the most difficult of the group to penetrate. Available records show that the catches of tortoises made here by the great whaling fleet of the 19th Century were small as compared with those made on more accessible islands.

The tortoise of Indefatigable is known as *Testudo porteri.* No naturalist has as yet studied the indigenous animals and plants of this island except in the vicinity of certain bays. Like the others it suffers from the plague of wild dogs, pigs, cats and rats, and the remnant of its tortoise life is destined to disappear.



The shore of Charles Island at Black Beach Anchorage. The *Albatross* is anchored off shore about a mile.

While on the way to Albemarle, the *Albatross II* stopped at Duncan Island where a party of ten men recently sent ashore from Mr. W. K. Vanderbilt's yacht, obtained five tortoises. Our party of eight men spent two full days exploring its steep thorny slopes. We examined both lower and upper craters and reached the top of the mountain without finding any trace of tortoises. This small but exceedingly difficult island has been frequently visited and has yielded occasional tortoises up to the present year. It is possible that Mr. Vanderbilt's party got the last of them.

Duncan furnished hundreds of tortoises to whaleships as late as the middle of the past Century, when four vessels took away 356 tortoises between 1848 and 1863. Tortoises were reported to be plentiful there when explored in 1906. Man is their only enemy on this island except rats which accounts for their persistence on an island only three miles long. Other domestic animals if ever introduced probably did not survive the dry season. The island is waterless except during rains. The tortoise of Duncan Island (*Testudo ephippium*) is well represented in museum collections and the New York Zoological Park has three adult specimens —the gift of Mr. Vanderbilt.

I may be pardoned for mentioning a coincidence in connection with the voyage of the *Albatross* II: When we landed at the Galapagos on April 4th, I recalled that it was forty years *to a day* since my first landing there from the original *Albatross* in 1888. During a second voyage there with Alexander Agassiz in 1891, I captured at Duncan Island the only tortoise found during that cruise, although no special search was made for them.

On the voyage of 1888 we obtained sixteen tortoises, some of them from Abingdon Island where they have since become extinct. This species is (*Testudo abingdoni*).



Along the shores of Charles Island where the lava ledges dipped down into the sea the furious rollers swept in perpetually. No matter how calm the day, the surf tore at the ragged reefs relentlessly.



A Galapagos "apple tree" (*Hippomene*) at Black Beach, Charles Island. The sailor is pointing to the position of the nest of the yellow warbler shown in the lower picture.

The species represented by our collection from the mountains of southern Albemarle is probably *Testudo guntheri*. It has not yet been compared with other species described from that island. The other tortoise of southern Albemarle (*Testudo vicina*) which inhabited the low country seems to have disappeared. We found no traces of it. The former importance of the Galapagos tortoise as a source of food is but little understood at the present time. The narratives of the early navigators who visited the Galapagos all contain references to it. Great numbers of tortoises were taken for food by buccaneers, sealers, merchantmen and whalers. Many of the whaling vessels made catches of 300 or more, one in 1834 taking 500. Tortoises were kept on board without food or water for months and killed as required.

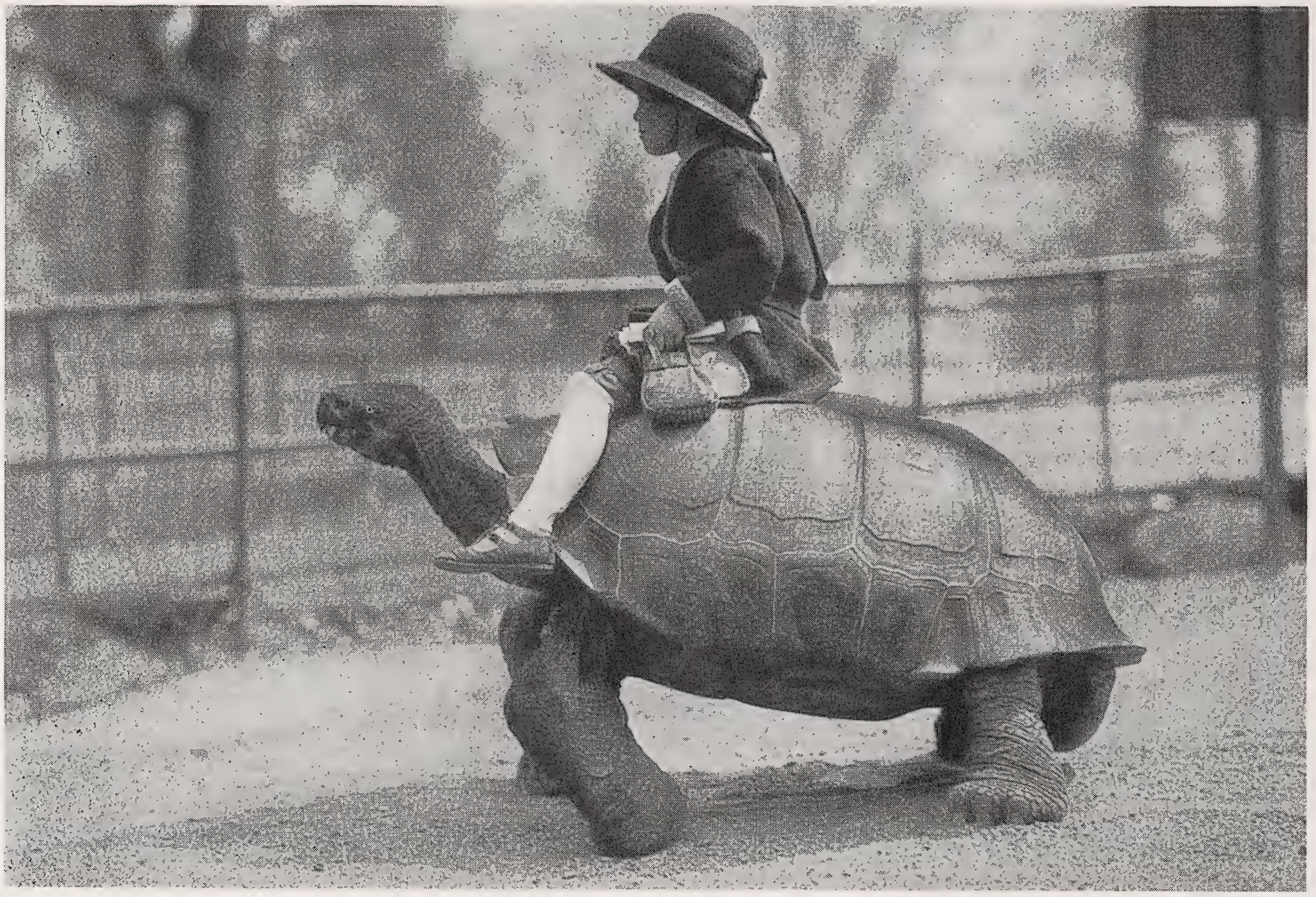
It has been estimated that ten millions of tortoises have been taken from the Galapagos since their discovery. The Galapagos tortoise had apparently a food value to the Pacific whaling fleet for the best part of a century, not unlike that of the bison to the settlers of the great plains.

The Extinct Tortoise of Charles Island.—While the *Albatross* II was at Charles Island we learned of the existence of a cave containing remains of tortoises. Our informant, a Norwegian engaged in killing wild cattle for their hides, led the way to what proved to be a storehouse of very old skeletons. The best of this osteological material, amounting to several closely packed barrels in quantity, was secured for study.

Dr. Robert Broom, well known British palaeontologist, who happened to be in New York at the time of our return, spent several days in the examination of the collection. It represents many more adult specimens of what is unquestionably the indigenous tortoise of Charles Island, than have hitherto been available. Dr. Broom identifies this much dis-



Nest and egg of the yellow warbler of the Galapagos. The branch with inedible fruit is from the Galapagos "apple tree" (*Hippomene*).



Galapagos tortoise from Albemarle. This is the largest tortoise in the collections of the Zoological Park; a resident of the Park for twenty-four years. He weighs 350 pounds and his age as fondly respected in press agent circles has been variously estimated from 50 to 300 years. No doubt his longevity is very respectably ancient, but it is without authentication. Unquestionably he is the most popular and most widely advertised member of the Zoological Park, a subject that the city editor or news-reel chief will welcome any time.

cussed species as *Testudo galapagoensis* of Baur. His discussion of the subject, too lengthy for presentation here, is reserved for publication in *Zoologica*.

It would be difficult to imagine a more effective trap for tortoises than the well-like entrance to the cave from which the skeletons were taken. It must have operated automatically as a death trap for centuries. The brushy half-concealed entrance is merely a hole in the ground a dozen feet in diameter and twenty feet deep. With a steep slope at one side, the unluckly tortoise that tumbled in did not necessarily strike bottom with a fatal crash, but rather rolled down an incline it could not ascend.

The rocky floor of the cave is not wide but leads into a few low passages under the lava, all strewn with dry bones of tortoises that had crept everywhere in search of an outlet. The brittle remains of the earlier victims had been crawled over repeatedly and gradually broken up by those that were entrapped subsequently from time to time.

It is not likely that the latest and best preserved of these entered the cave less than ninety years ago. According to the log-book records of seventy-nine whaleships examined by the writer, the last tortoises were taken from Charles Island in 1837.

The bleached and bony remains of those not too antiquated and fragile to be removed, had long lost their dark horny plates which lay curled and twisted beside them. In a dozen of these, both carapace and plastron were practically intact, while skulls and leg bones had usually been disturbed and scattered. A considerable amount of broken tortoise remains had long since become mixed with the soil of the cave floor. The later arrivals lay where they died, their large white carapaces show-

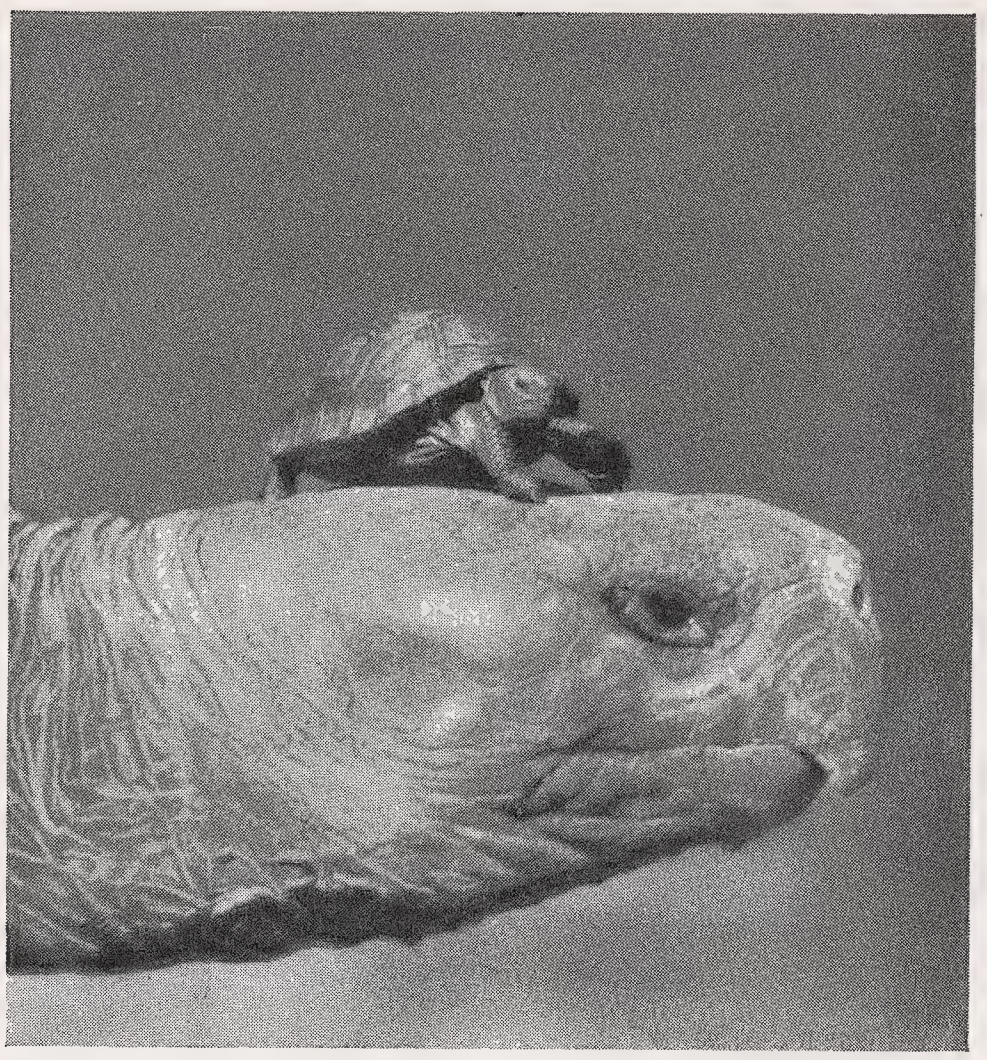
TORTOISES TAKEN FROM THE GALAPAGOS ISLANDS BY CERTAIN WHALESHIPS FROM 1811 TO 1884

(*Not included in records published in Zoologica in* 1925)

Year	*Vessel*	*Island*	*Tortoises*
1811	SHIP *Winslow*	Galapagos	200
1824	" *Loan*	Charles	394
1828	" *India*	Charles	100
1831	" *Leonidas*	James	55
1831	" *Good Return*	Hood	86
1833	BARK *Octavia*	Charles	235
1835	SHIP *Roger Williams*	Galapagos	86
1839	" *Champion*	Galapagos	500
1840	" *Rousseau*	Chatham	65
1840	" *Frances*	Albemarle	113
1841	" *Frances*	James	179
1842	" *Frances*	James	10
1844	" *Iris*	Galapagos	24
1845	" *Vineyard*	Albemarle	3
1845	" *Seminole*	James	58
1846	" *Seminole*	Chatham	190 plus
1848	" *Golconda*	Chatham	4
		Albemarle	75
1848	" *Ceres*	Chatham	177
1850	BARK *Pantheon*	Chatham	40
1851	SHIP *Hillman*	Albemarle	4 plus
1852	" *Niger*	Chatham	47
1859	BARK *Columbus*	Galapagos	70 plus
1869	" *C. W. Morgan**	Galapagos	63 plus
1872	" *Edward Everett*	Albemarle	36
1882	" *Atlantic*	Charles	3
1884	SHIP *James Arnold*	Abingdon	1

Total number of visits by the above-named twenty-three vessels—26. Total catch 2818

*F. H. Reed of Bark *Palmetto* same year saw deck of *C. W. Morgan* "covered with tortoises."



Old age and youth at the cross-roads. The smallest Albemarle Island tortoise perched on the head of our largest Galapagos specimen.

ing conspicuously as our flashlights were turned in their direction.

Tortoises Taken from the Galapagos Islands by Whaleships.—After the publication in 1925 of the writer's studies of logbooks of whaleships preserved in the libraries of New Bedford, Salem and Nantucket, he received additional records relative to Galapagos tortoises copied from logbooks in private libraries. For these he is indebted to Mrs. Johnson Whiting of West Tisbury, Massachusetts, Mr. Arthur C. Watson and Mr. G. H. H. Allen of New Bedford, Massachusetts, and Mr. Charles H. Taylor of Boston.

The records first published were those of seventy-nine whaleships which took 13,013 tortoises from the Galapagos Islands between 1831 and 1868. The additional records here published are those of twenty-three whaleships which carried away 2,818 tortoises between 1811 and 1884, making a total of 15,831 taken by 105 vessels, two of them having made visits subsequently. The average per vessel is 122. During a part of this period there were over 700 vessels in the American whaling fleet. It is evident that the numbers of tortoises taken from these islands during the long period of whaling activity in the Pacific must have been very great. The extent to which they were used for food will be better known when more logbooks of whaleships have been examined.

Endurance on Board the Ships.—There is abundant evidence that the tortoises could live many months without food or water and yet remain in satisfactory condition as fresh meat animals. The following records are from logbooks of whaleships:

Ship *Winslow*, 1811. "Had one on shipboard more than a year without having anything unless he drank water when it rained. They become very poor in flesh after six months."

Bark *Equator*, Sept. 8, 1846. "Killed our last Terpen which has lived on air for four months and made a good mess for all hands."

Ship *Pocahontas*, 1852. "Killed the last Turpin after having them on board nearly 9 months."

Mr. George A. Grant of Nantucket who visited the Galapagos in the ship *Niger* in 1852 writes: "Two years later when the ship arrived at New Bedford, a tortoise was found alive in the lower hold."

Morrell says, "I have had these animals on board my own vessel from five to six months without their once taking food or water. They have been known to live on board some of our whaleships for fourteen months."

Porter's testimony is that "No description



The smallest tortoise brought from the Galapagos. This is the same specimen as shown in the upper picture. Weight three and three-quarter ounces. From a photograph by H. L. Gaddis.



The spineless cactus found on Charles Island at Black Beach Anchorage. It was growing in a plot of ground about two acres in area. It was the only specimen.

of stock is so convenient for ships to take to sea—they require no provisions or water for a year—they have been kept eighteen months."

Edible Qualities.—The narratives of the early navigators and the logbooks of the whalers who visited the Galapagos later, contain only favorable testimony on this point.

Capt. Wm. Lewis of the bark *Samuel and Thomas* at the Galapagos in 1865 says: "We valued them very much for fresh meat. I don't think anything ever tasted much better than terrapin liver."

Weston Howland, a whaler, at the Galapagos in 1830, after describing the collecting of tortoises says they furnished "a supply of delicious food for a month or more."

Capt. Bumpus visited the islands in 1860 in the ship *Louisiana.* He speaks with enthusiasm of tortoises as food.

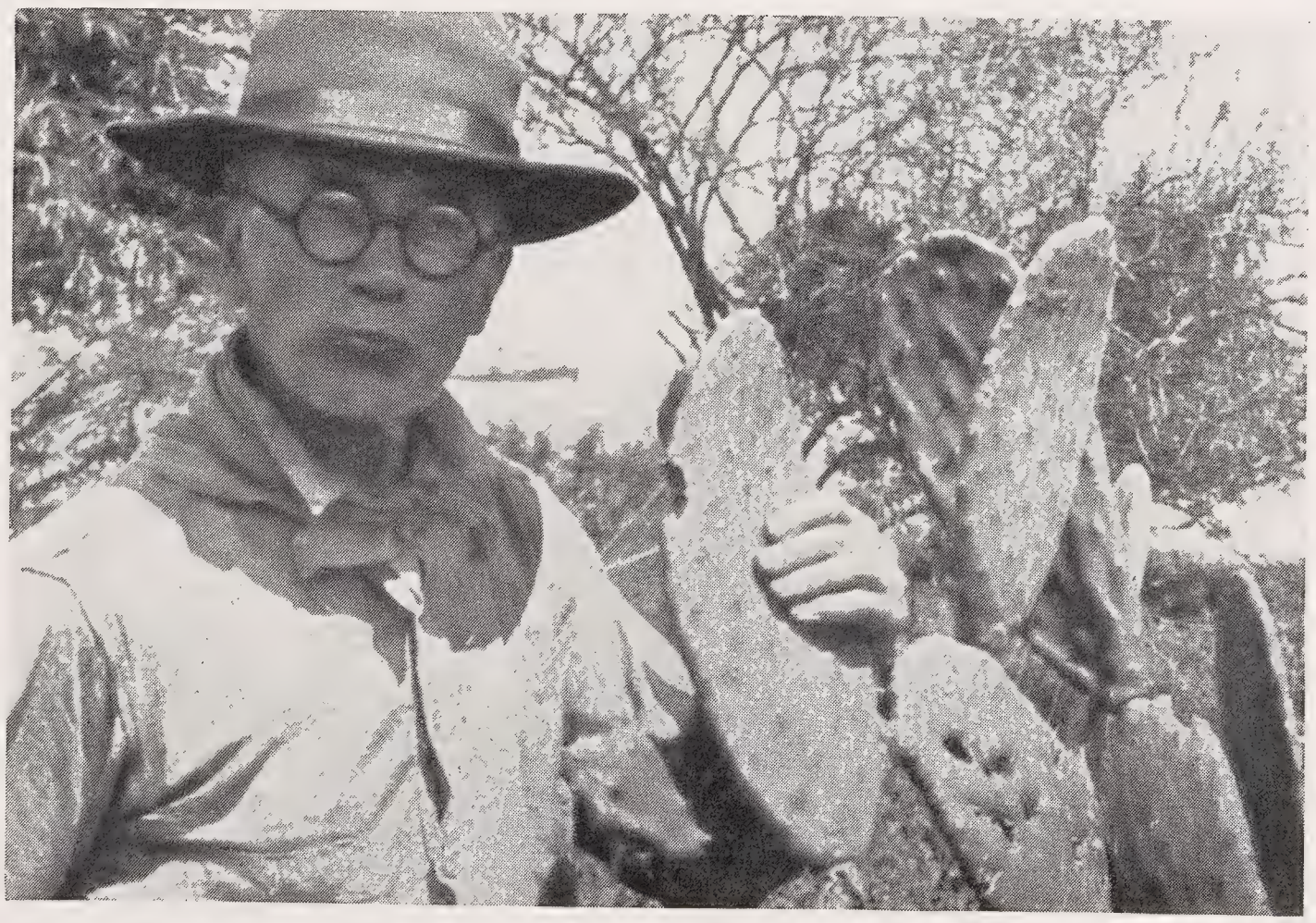
Capt. Thomas Crapo with the bark *Greyhound* in 1858 says: "their flesh is unsurpassed as food—its equal cannot be found."

Admiral Farragut who served as a young officer with the U. S. S. *Essex* at the Galapagos in 1813 wrote: "The meat cooked in almost any manner is delicious."

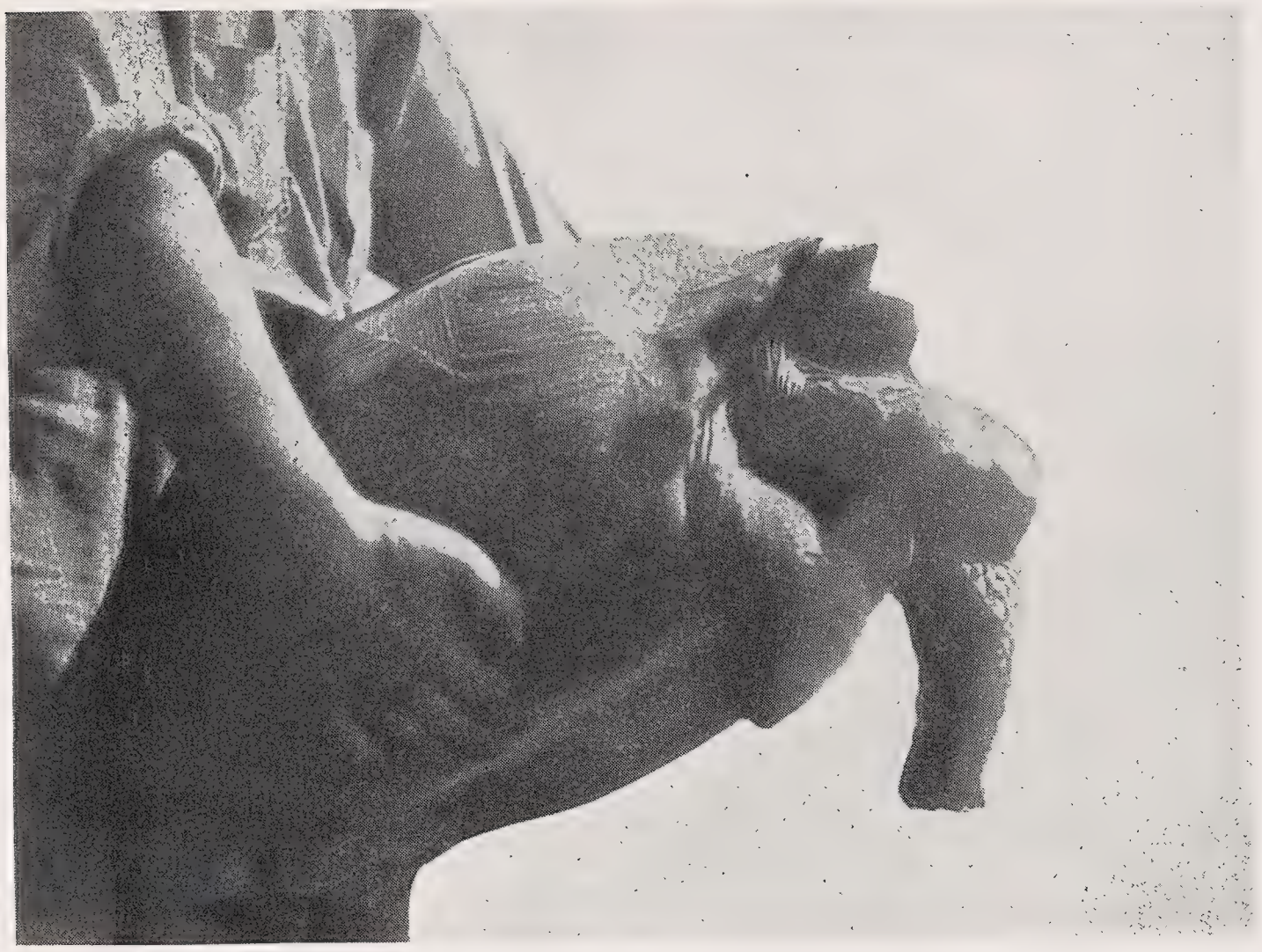
Propagation of the Galapagos Tortoise.—The tortoises now colonized at points near the southern border of the United States are young and mostly of small size, few weighing more than fifty pounds. Those at Panama have weights up to ninety pounds. The tortoises in Bermuda all weigh less than ten pounds. All have already shown gratifying growth, the degree of which undoubtedly depends upon extent of range and access to grass or other food at all times.

The colony of thirty tortoises at San Diego enjoys a well-fenced range of about five acres of hillside in the zoological garden. This area is well supplied with coarse grasses, low bushes and has a few trees.

The tortoises, twenty in number, at the Boyce



This cactus was entirely devoid of spines, and Dr. Townsend experienced no discomfort in biting a piece from one of the thick, fleshy leaves. The tortoises ate it avidly.

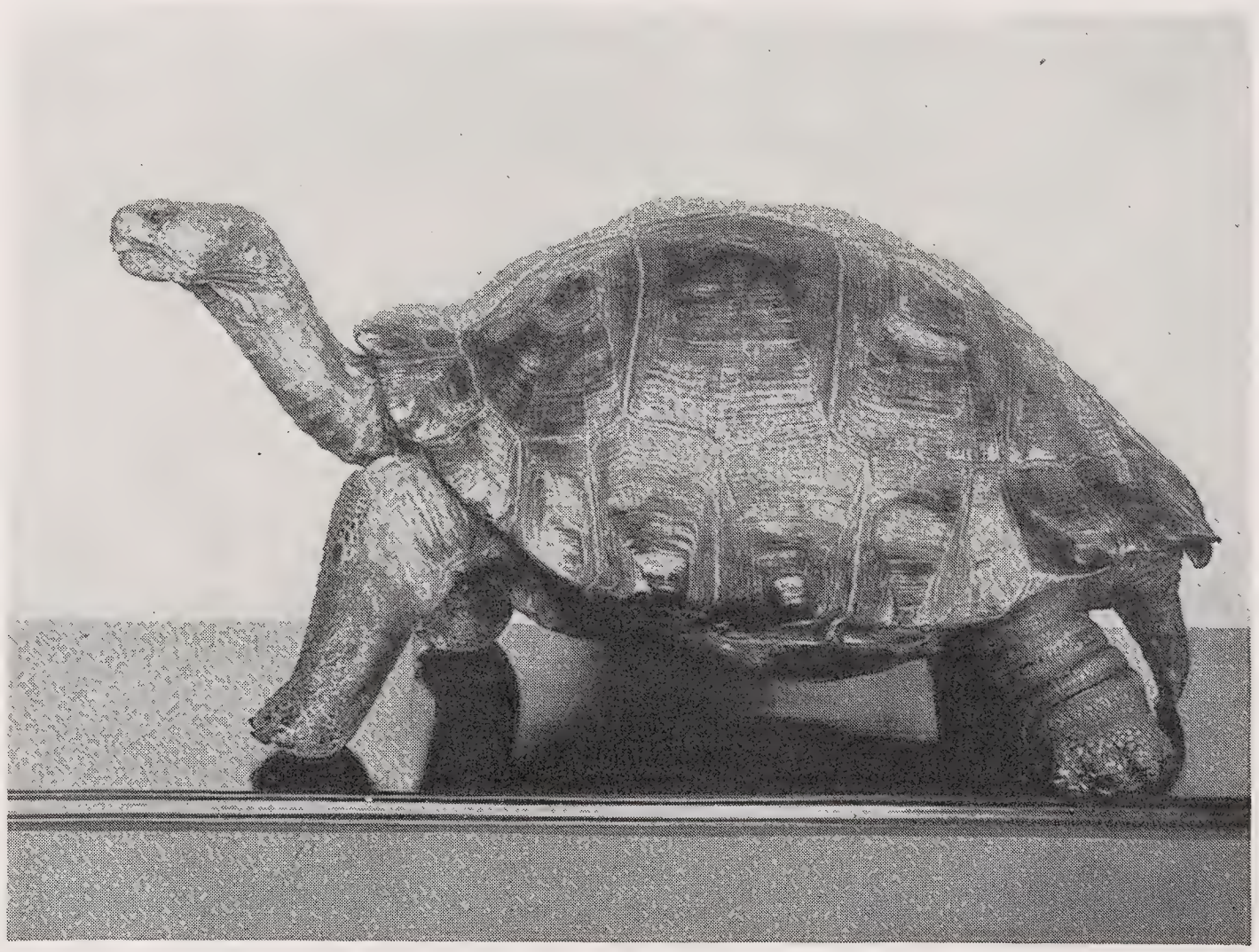


The largest tortoise (ninety pounds) that was captured on Albemarle. An idea of the size may be gained by comparison with the sailor who held it for Mr. Gaddis to photograph.

Thompson Southwestern Arboretum, Superior, Arizona, may also be regarded as well placed. They have half an acre of desert land thickly grown with cactus—their favorite food, a cement drinking basin and a stone and concrete refuge during chilly weather. These tortoises were located through the cooperation of Dr. D. T. MacDougal, Director of the Desert Laboratory at Tucson, Arizona.

The three colonies of fifteen tortoises each, located in Zoological gardens at San Antonio, Houston and New Orleans have grassy ranges averaging a quarter-acre in extent. All are provided with cement drinking basins, the tortoises at San Antonio being already provided with the stone house pictured on page 168.

In a private letter Col. M. L. Crimmins, U. S. Army, sends the following relative to the tortoise colony in the Zoological Garden at San Antonio: "The Galapagos tortoises now have a house measuring 7x14x5 feet high, with a half glass roof and 3x3 feet glass windows in the ends. They are fed lettuce, beet tops, etc., to the extent of about fifteen pounds a day. There is never anything left after six hours. They keep the young grass in their enclosure cropped close. They eat any kind of coarse grass, taking a piece three feet long by the end and eating it up without letting go. They are eager for watermelon rinds and any kind of vegetables. I burned the spines from prickly pears, but even if these are not singed, they bite out chunks and when the spines get in the corners of their mouths, brush them off with the fore legs. One of the tortoises followed me like a dog and most of them will eat from the hand. The sight-seeing busses go by their enclosure, where there is a large sign: Gala-



Galapagos tortoise (*Testudo vicina*) from Albemarle Island. It is a male specimen and weighed when captured (1899) 29 pounds. It lived in California until 1914 when it weighed 415 pounds. Photograph from the Los Angeles Museum.



Radiographs of two Galapagos tortoises showing the anatomical skeletal structure, and some of the organs of the abdominal cavity. An interesting feature of the pictures demonstrates in the photograph at the left the power of the tortoise to retract the head entirely within the body cavity for protective purposes and, as a further measure of safety, to fold over it the two front legs. The granular appearance of the large intestine is caused by sand which adhered to the food that the tortoise had been eating. From radiographs made for the Society by Dr. L. T. Le Wald.



Tortoises on the beach at Villamiel, Albemarle Island. At this place, the colonists cultivated the cocoanut and banana. There was no tropical vegetation elsewhere.

pagos Island Tortoises. The tortoises are doing well and are livelier than when received. There are as yet no signs of breeding."

Several reports have been received relative to the tortoises at Panama, all to the effect that they are in good condition. The Zoological Society is indebted to Mr. James Zetek of the Biological Station at Barro Colorado Island for helpful service in connection with this colony. The tortoises in Bermuda occupy grounds adjacent to the Bermuda Aquarium of which Mr. L. L. Mowbray, formerly of the New York Aquarium, is Director.

There is little information on record respecting the growth of the giant tortoise. A twenty-nine pound male (*Testudo vicina*) taken from Albemarle Island in June, 1899, by Edmund Heller, lived at Riverside in southern California, until April, 1914, when it died from exposure on wet ground. Its weight at death was 415 pounds, the carapace measuring forty-one inches. It is also recorded that this tortoise increased from 29 to 350 pounds in seven years. Mr. Heller states that it practically doubled its weight annually while young.

A tortoise of the same species was received at the New York Zoological Park in 1904, its weight being 140 pounds. It weighs at the present time (1928) only 355 pounds. Lacking in winter, the outdoor life enjoyed by the California tortoise, its growth has been very slow. Nevertheless it is a healthy and powerful animal, carrying easily a full grown man.

We have now many young tortoises colonized at several points under various conditions and all in mild climates. As all have been numbered and weighed, we shall before long acquire definite knowledge as to rate of growth and breeding age.

The following record of tortoises at Superior, Arizona, is illustrative of those located elsewhere. It will be seen that all gained weight in the first four months at this station.



Mountain camp of the tortoise hunters, Albemarle Island. De Sola and a few colonists went inland as far as Perry's Isthmus. Photograph by Ralph De Sola.

New York Zoological Society

Propagation of Galapagos Tortoises

ANNUAL RECORD

Station: Superior, Ariz. (Boyce Thompson Southwestern Arboretum.) Date: May 6, 1928

No.	LENGTH		WIDTH		Height	Weight Lbs.	Sex	REMARKS
	Straight	Curved	Straight	Curved				Weight Sept. 4, 1928
56	14 7/8	18 1/4	11 5/8	20 3/4	6 7/8	20		20 1/2 lbs.
57	12 7/8	16 1/2	9 5/8	16 3/4	6 1/8	11 1/2		15
58	13 5/8	17 3/4	10 1/8	17 3/4	6 1/4	14 1/2		17 1/2
59	13 1/8	16 5/8	9 7/8	17 1/2	6	11 1/2		15 1/2
60	14 3/8	19 3/8	11 1/8	19 3/4	6 3/4	20		22 1/2
61	13	17 1/4	9 7/8	17	6	10		16
62	14	18 5/8	10 1/2	18 3/8	6 1/8	16 1/2		20
63	14 1/8	18 5/8	10 5/8	19 1/4	7	18 1/2		20 1/4
64	17 1/4	21	13	22 5/8	8 1/8	28		28 3/4
65	18 1/4	22 3/8	13 1/2	24 1/4	8 1/4	32		36
66	15	18 7/8	11 1/4	16 1/2	7	19		22 1/2
67	13 3/4	18 1/8	11 1/8	18 1/2	6 7/8	15 1/2		17 1/2
68	14 1/8	18 5/8	11 1/8	19	7	18 1/2		21 1/2
69	13	17	10	17	6 7/8	11 1/2		17
70	15 1/2	20 5/8	11 7/8	21	7 5/8	20		26 1/4
71	15 5/8	21	12 7/8	21 1/2	7 5/8	24 1/2		28
72	15 1/2	19 7/8	12 3/8	20 1/2	7 1/8	21 1/2		25 1/4
73	15 7/8	20 1/2	12 1/4	20	7 5/8	24 1/2		29

Weighed and measured May 6, at Zoological Garden, San Diego, California, before shipment to Superior, Arizona.



Colonists on the beach at Villamiel with some of the tortoises captured on Albemarle Island. The expedition landed on Albemarle, Easter Sunday.

Returns from three other stations show still greater increases in weight. The indications are that all may double their weight annually, as did Heller's specimen in California.

Public Interest.—The public has shown a decided interest in the attempt to save and propagate the giant tortoise, if its extent may be judged from the mass of newspaper clippings received from various parts of the country. The great interest shown by naturalists was, of course, to be expected.

From *Nature* (London) August 4, 1928.—"The expedition sent by the New York Zoological Society to the Galapagos Islands in the spring of the year has returned safely with its mission fulfilled. Its object under the leadership of Dr. C. H. Townsend was to save alive a remnant of the giant tortoises of the islands, and preliminary reports published in the New York *Times* and *Science* show how desirable that action had become.

"In the days of Dampier (1684) the tortoises were innumerable; in later times seventy-nine New Bedford whalers carried off 13,000 tortoises, an invaluable article of food. Now the tortoises are extinct on all but two or three of the islands in the group, and Dr. Townsend confirms the reports of recent visitors that the giant tortoise cannot long survive there, since all the eggs and young are destroyed by wild dogs, pigs, cats and rats. Once common throughout the islands, the tortoises are now confined to mountainous regions difficult of access to man.

"The only hope of keeping the stock alive was to establish it in conditions where its safety and continuance could be assured so far as human devices go. Accordingly, the expedition captured 180 live tortoises and, having transported all in safety, it has placed breeding colonies of 15 to 30 individuals at half a dozen stations in tropical and subtropical Central and North America in the belief that at some, if not all of the stations, breeding and successful rearing of young will take place. Since all the captured specimens have been numbered and weighed, the experiment should yield information as to rate of growth and age. A dozen skeletons of the long-extinct tortoise of Charles Island were also obtained by the expedition."

The arrival of the tortoises in this country was followed by a score of applications for specimens, of which the following is the most interesting:



Carrying the tortoises to the boat on the shore at Villamiel. When all the tortoises fruit and live stock were towed away, there were three very deeply laden craft.



The harbor of Villamiel, Albemarle Island. The house on the outlying lava ledge is the home of one of the colonists. This is a very dangerous waterway, and must be gained through two roaring lines of breaking seas. One instance when the launch in charge of the bo'sun was attempting the passage, the boat, a ship's dingy with installed motor, was caught in the breakers on a lava reef a half mile from shore, overturned and sunk in twenty feet of water. Mr. Gaddis, who proved himself a very cool person in an exceedingly dangerous predicament, succeeded in manning the small skiff, which had been towing astern, and saved his companions, two of them being unable to swim.

Lihue, Kauai, Hawaii, July 6, 1928.—"There has come to my attention a clipping from a San Diego paper telling of the return of the New York Zoological Society's Expedition headed by yourself, from the Galapagos Islands and the importation into the States of fifty specimens of land tortoises from the islands for distribution in various parts of the southwest. The paper states, also, that one hundred more of the tortoises are to follow.

"We in Hawaii are much interested in your experiment, for in whaling days of the past the whalers occasionally left one or two of these so-called giant turtles in Hawaii. They seemed to thrive here but no effort was apparently made to propagate them. For many years one was a pet in the garden of my missionary grandfather. Just before the Great War an agent from Regents' Park, London, appeared and carried off several tortoises—I believe as many as he could collect—and I have heard of no more here since. Our's went with others, as a sacrifice to science, as we were told the species was already extinct and these specimens were wanted for study and propagation.

"Now, the object of this letter is to inquire if any of the specimens you have brought to America may be secured for Hawaii, where we know they will live? I would be willing to bear the expense of having at least a pair sent out here and could secure other orders. I trust that this request will not trouble you, and I would much appreciate being put in touch with sources where the animals may be obtained."

To this the following reply was made:—"We are interested in your letter relative to tortoises and have had in mind the idea of sending a few breeders to Hawaii. We have already established breeding colonies in Panama, California, Arizona, Texas and Louisiana. Others will be located in Florida and Porto Rico. None of the animals brought back have reached breeding age, although some of them weigh more than 50 pounds.

"All colonies have been given a range of about an acre of ground and are tightly fenced to prevent the escape of young and their destruction by rats, cats and other pests. A little later we may take up with you the establishment of a breeding colony in Hawaii.

The Zoological Society would be much indebted for any information you can give respecting tortoises that have lived in your islands. How long they were kept and what sizes they attained."

Public Misunderstanding.—Since our return from the Galapagos we have observed



One of the youngest settlers with his own contribution to science. Life at Villamiel was a serious problem to the natives and the Society's expedition happened along in just the right season. They were nearly destitute.

that in speaking of giant tortoises, some one invariably breaks into the conversation with remarks about big sea-turtles and expresses surprise that they should be near extinction, failing utterly to comprehend that such have nothing to do with the subject of giant land tortoises.

Circular Letter Sent to Correspondents.—"Numerous letters having been received respecting tortoises brought from the Galapagos Islands by the New York Zoological Society, the following general statement is made for the information of inquirers:

"All of the Galapagos tortoises are to be devoted to attempts at propagation—none will be sold.

"All of the tortoises now colonized in zoological gardens remain the property of the New York Zoological Society and may not be removed without its sanction.

"No tortoises have been placed with private parties—all are under the protection of scientific or other responsible associations.

"None will be placed in zoological gardens situated north of the latitude believed to be climatically favorable to their propagation. Five of the colonies already located are near the southern boundary of the United States.

"Should these animals increase under the present experimental conditions, as is expected, the Zoological Society will eventually arrange to make them available to breeders as food producers suitable for southern and especially for arid regions."

Circular Letter Sent to Cooperating Organizations:—"The Executive Committee of the New York Zoological Society appreciates the ready cooperation of the managers of zoological gardens in the South, participating in its efforts to propagate the giant tortoise of the Galapagos Islands. This animal formerly of great food value, is threatened with extermination in the only region where it ever existed.

"The tortoises remain the property of the New York Zoological Society for the present and may not be sold or removed without its sanction. The Zoological Society is interested solely in the increase of these animals, with the ultimate view of wider distribution as a food species that may be of value in the southern states. The Galapagos tortoise is hardy, grows rapidly and attains notably large size.

"The tortoises already placed in zoological gardens may remain there indefinitely as exhibits. After growth to large size, a few males or fe-



The large boat anchored off the shore and it required several trips with the dory to load the tortoises. This was a gala day for the natives and they entered into the matter with tremendous enthusiasm.



The tortoise house at the Zoological Garden, San Antonio, Texas. Some of the Albemarle tortoises have been colonized here. Photograph by courtesy of Col. M. L. Crimmins, Fort Sam Houston, Texas.

males may be called for to start breeding stations at other southern points not yet selected, the sexes of the tortoises not being at present distinguishable. In any event the cooperating establishment will not be deprived of an exhibit.

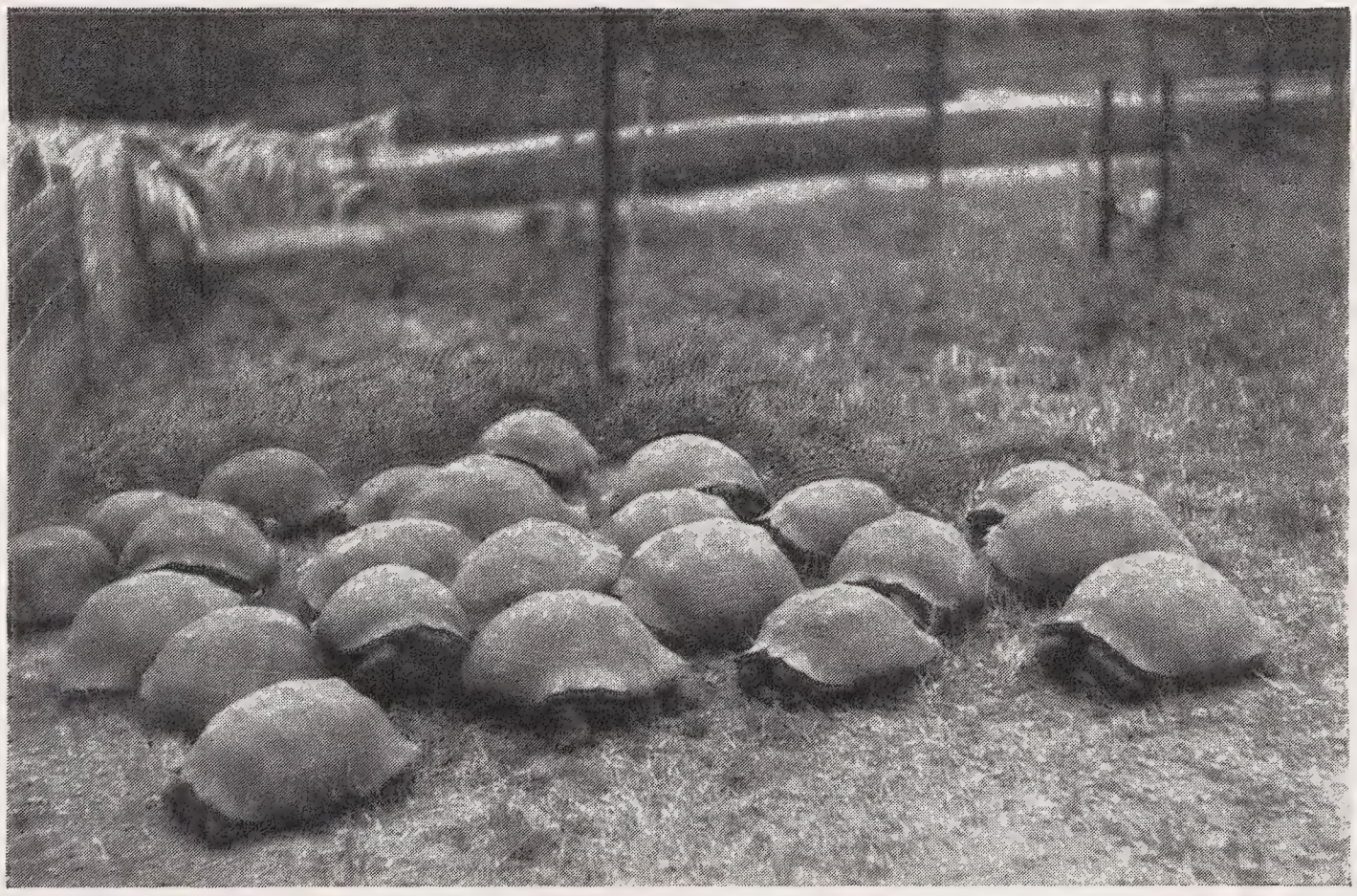
"Attention is directed to the value of these animals, the procuring of which has cost the Zoological Society many thousands of dollars. They should be kept well fenced, fed on grass and vegetables, provided with shelter and after breeding, precaution should be taken against the escape of the young or their destruction by rats.

"All of the tortoises distributed have been numbered, weighed and measured. These and other scientific records will be made annually by a representative of the Zoological Society until the little-known changes due to age and growth are ascertained."

Galapagos Land Birds.—The object of the expedition of 1928 was to procure tortoises for propagation. Little attention was given to other matters. Guns and other collecting outfit were not carried. With a long-barreled dust-shot pistol the Director shot twenty of the indigenous land birds which he skinned and preserved.

The black finches, the flycatcher and the yellow warbler were nesting at the time of our visit, early April. Some of the new nests were empty, perhaps robbed by cats. It is probable that cats and rats get many nestlings. There is little food for cats in these islands except birds, there being no mammals other than bats. The agile lizards are probably able to escape them. What effect cats have on the introduced rat is unknown. Both feed on the newly hatched and tender tortoises. One large species of finch that inhabited Charles Island has not been seen since Darwin's visit in 1834. It may have been exterminated by cats and rats. Dr. W. L. Abbott writing in 1894 of the giant tortoise of Aldabra Island in the Indian Ocean says: "The greatest enemy of the land tortoise is the common rat which swarms upon Aldabra and eats the young as soon as they are hatched."

Marine Iguanas.—These being easily obtainable, the expedition left Albemarle Island with a score or more on board. Like those



Galapagos tortoises at San Diego, California. This is a portion of the tortoises brought back by the Townsend expedition.

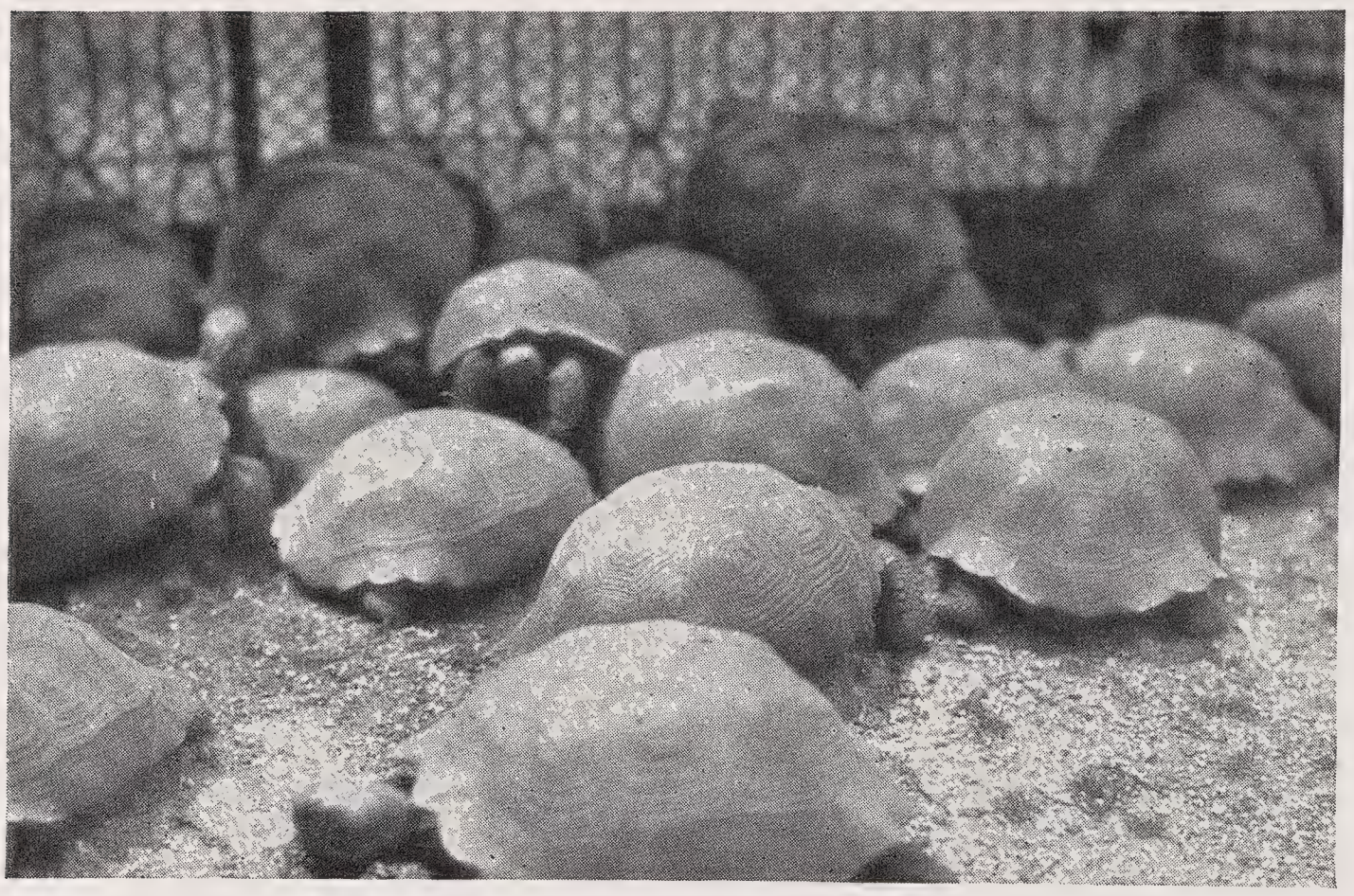
taken alive by others, few survived the voyage to New York and these soon died. On board ship they were supplied with sea water and also the sea-weeds on which they feed, but none were observed to take food at any time. A few that escaped from their quarters from time to time were to be seen on the after deck among the tortoises, or even up on the rail but none so far as I know went overboard.

A Peruvian newspaper of recent date contains a note to the effect that a French company has secured a concession from the Government of Ecuador for the killing of iguanas for leather. As the land iguana is no longer common on the islands, the more easily captured marine species, would suffer greatly by such operations. Iguana hunting on the shores of Narborough and Albemarle would contribute to the extermination of the rare flightless cormorant known only to those islands.

Spineless Cactus. — While exploring on Charles Island, I found a cactus so different from all others present, as to attract notice. It was entirely devoid of spines, its large pulpy leaves being as smooth as a watermelon. There was a plant as high as my head with two or three lower ones close beside it and no others of the kind in sight. Failing to find another we called some sailors to help, but an extended search revealed no more. I collected some of the fallen leaves which had taken root and sent them to the ship. These have been planted at the botanical station in the Canal Zone and at the Desert Arboretum in Arizona. This spineless cactus is not mentioned in botanical papers on the Galapagos. It was evidently growing there long before Mr. Burbank's smooth cactus was developed and probably represents an undescribed species.



Tortoises from Albemarle Island in the tortoise yard of the Zoological Gardens at New Orleans. From a photograph by Henry D. Whiton.



Some of the Albemarle Island tortoises that were shipped to San Antonio, Texas. Photographed in the Zoological Park, New York.

List of Officers of Cooperating Organizations

Dr. Harry M. Wegeforth, *President Zoological Society*, San Diego, California: Dr. F. J. Crider, *Director Boyce Thompson Southwestern Arboretum*, Superior, Arizona; Mr. A. H. Hanson, *Superintendent of Parks*, San Antonio, Texas; Mr. C. L. Brock, *Superintendent of Parks*, Houston, Texas; Mr. Marion Weis, *President Zoological Society*, New Orleans, Louisiana; Mr. J. H. K. Humphrey, *Assistant Chief Quartermaster*, Balboa, Panama Canal Zone; Mr. L. L. Mowbray, *Curator of the Aquarium*, Bermuda.

TARPON BEHAVIOR IN CALCASIEU PASS

By HENRY D. WHITON *and*
CHARLES HASKINS TOWNSEND

THE Calcasieu River flows into the Gulf of Mexico at a point about thirty miles east of the Texas line in Cameron Parish, Louisiana, and discharges through a channel in the treeless lowlands some six miles long known as Calcasieu Pass. Its two principal branches rise in the northern part of the state and flow through some of the wildest country still left in eastern America. At a number of points the river expands into lakes of considerable size; Calcasieu Lake, or as it is called locally Grand Lake, is the largest—being some fifteen miles long and ten miles wide. The average depth of this lake is not over six feet and it is a playground and spawning ground for myriads of fishes.

After the river makes its exit from the shallow Calcasieu Lake, it flows through the Pass and enters the Gulf of Mexico. This rather broad and in certain parts shallow channel is the resort of great numbers of tarpon, especially during the months of August, September and October. These fish in the Pass do not seem to feed during the flood tide, but when the ebb tide sets in and the flow from the lake begins they suddenly appear on the surface and their activity holds one spell-bound. While feeding they paid no attention to us at all, and were in such great numbers that we sometimes struck them accidentally with the oars while rowing among them. Each time one was hit with an oar we got a good wetting as the fish would explode and disappear.

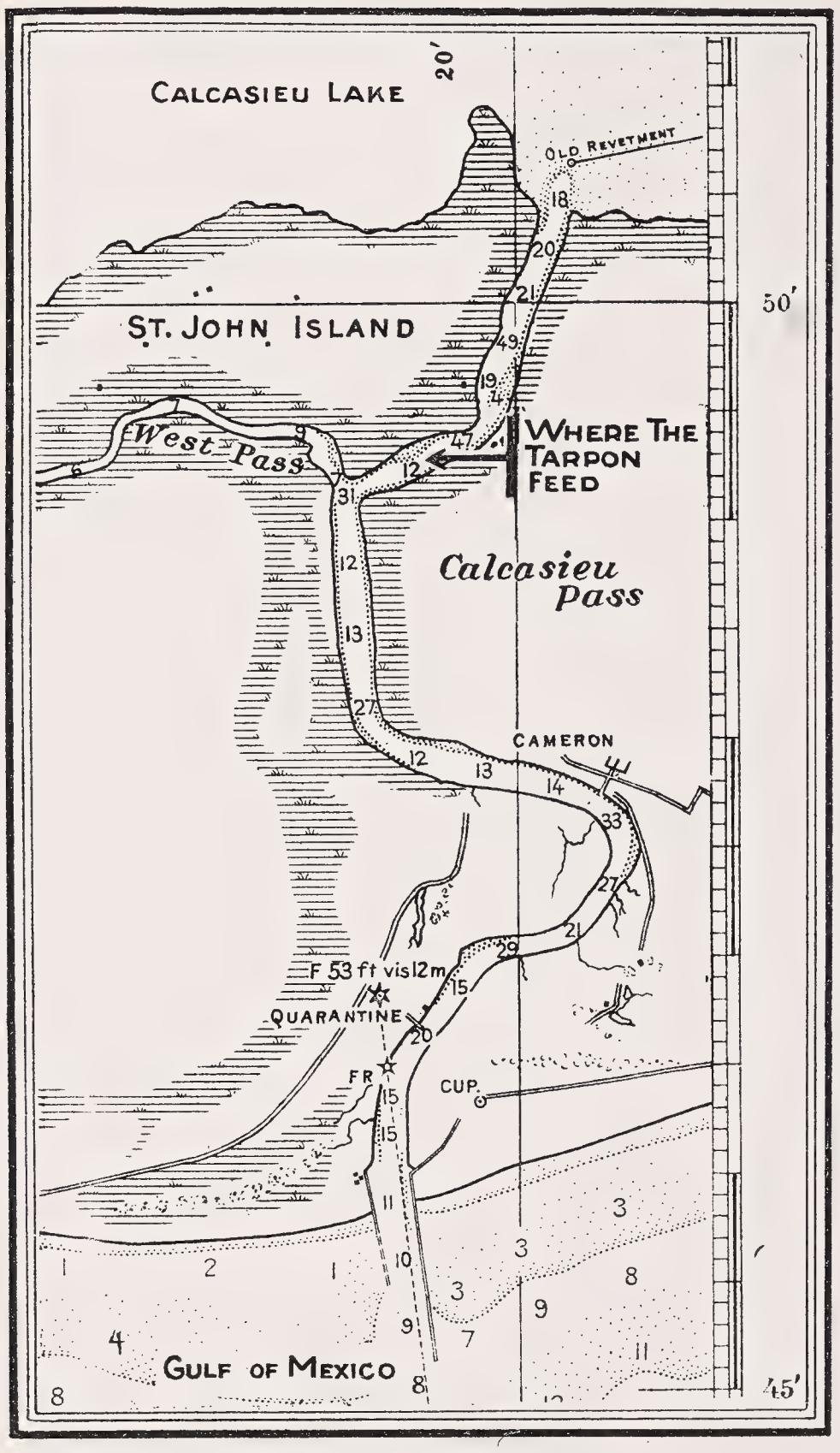
Knowing just when and where to get their food in this Pass the tarpon gather in large numbers in the shallow section a mile below the lake, where the stream is so choked with oyster reefs that the bottom may be touched almost anywhere with an oar. The width of the Pass at this point is about 400 yards, but there is a twelve-foot channel down the south side. This is the section most frequented by the feeding tarpon and is less than a quarter of a mile in length, although tarpon range from the Gulf up to Lake Charles, a distance of about sixty miles.

Just before the ebb begins the tarpon would appear in great numbers, at first moving slowly about, their dorsal fins showing above water. But this quiet scene quickly changes to one of wildest activity. With the setting in of the ebb tide there was a strong movement of half-grown "cutlass" or "scabbard" fishes from the lake—which the tarpon tribe learned centuries ago to lie in wait for. Their appearance marks the beginning of a spectacle worth seeing and which continues during most of the ebb. The tarpon suddenly appear everywhere, darting, whirling about and splashing at the surface, until the whole width of the Pass is swirling with their wild rushes. The frightened "cutlass" fishes soon became visible, their bright silvery forms darting to the surface in all directions, to escape the mad pursuit. Their numbers must be very great; we took from the stomach of our one tarpon fifty-two of these fishes, which amounted to about a peck in quantity. Cutlass fishes averaging a foot in length were the only food it had taken. A single "cutlass" captured with a cast net, proved a taking bait. The tarpon paid no attention to live blue crab, a favorite bait in Florida waters.

From our house boat, anchored in mid stream at the head of the tarpon feeding ground, all on board were able to observe the activity of the big fishes during the ebb tide.

In compiling a list of tarpon foods from angling works we found no mention of the "cutlass." This fish (*Trichiurus lepturus*) occurs along our coast from the Gulf north to Massachusetts, but is nowhere common. Large adults reach a length of five feet. The brackish waters of Calcasieu Lake must be well supplied with "cutlass" fishes of the size we observed.

We spent Friday, Saturday and Sunday, August 10, 11 and 12, 1928, on a fishing trip to the Pass, and worked the tarpon on each



Sketch map of Calcasieu Pass, Cameron Parish, Louisiana. From a drawing made by the U. S. Coast Survey.

ebb tide. We actually hooked and played twenty-seven fish of various sizes, and succeeded in landing one. This high loss was due to the fact that the fish were hooked among the oyster reefs. After they had taken half of the line off of the reel they would foul it around an upstanding bunch of sharp-edged oysters and that would be the last of the fish and the tackle. One enormous fish on the line for nearly an hour was finally lost in this way.

On the first afternoon's fishing we found that they would not touch any of the conventional baits. We tried them on cut fish, live mullett, and blue crab, without result. Then a No. 7-B Wilson Spoon was trailed through the school.

The first afternoon the outboard motor being balky two of our friends took turns rowing us. The fish were so thick that the skiff often bumped into them and the oarsmen accidentally struck quite a number with the oars.

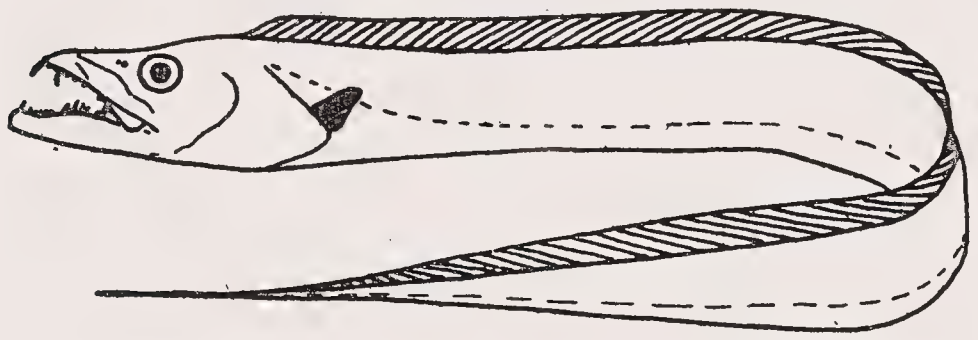
The men at the oars, by the way, had never seen a tarpon caught and didn't believe it could be done; they thought the attempt idiotic. Their excitement at seeing the first strike was such that it almost ruined everything, but they quickly settled down to business.

As we pulled through the school the first time with the Wilson spoon there was a strike but the hook missed. After the tenth strike without results we put a dead mullet seven inches long on the end of the Wilson spoon which worked wonderfully. When the fish



Henry D. Whiton and the five and one-half foot tarpon which he captured in Calcasieu Pass. From a photograph by Charles Haskins Townsend.

closed on the spoon and found the mullet he wasn't so quick to drop it and the result was that we soon ran out of Wilson spoons. As the water was shallow the line could not be kept clear of the oyster reefs, which meant loss of tackle. We were using a twenty-one thread Cuttyhunk line and a Julius Vom Hofe B-ocean reel.



The "cutlass" fish (*Trichiurus lepturus*) is one of the important foods of the Calcasieu tarpon.

The gathering twilight finally forced a stop and we returned to our houseboat *Marie* almost exhausted and without a fish, but after one of the most unusual afternoons of sport that anyone could imagine. We lost a half hour in the late afternoon through the accidental hooking of a brown shark in one of his starboard fins. As he had the last spoon we didn't want to lose it, so had to fight him long enough to recover the spoon, which was finally done.

On the afternoon of Sunday, the 12th, the time set for going home, we had not landed a single tarpon and had lost all tackle, with the exception of two Wilson spoons and a contraption known as the "Japanese Feather Tuna Bait." This is really quite startling to look at, being made up of bunches of white chicken feathers and other impossible things, but it proved to be a wonderful lure. We nicknamed it "The Snips of Snails and Puppy-dog Tails."

When the ebb tide started, which was now late in the afternoon, the thermometer stood at just 101 degrees Fahrenheit in the shade, with saturation at maximum and the mosquito army and horse-flies (especially our old friend *Stomoxys calcitrans*) tuning up for the evening session. We decided to try out the "Snips of Snails" first so we stuck it on the line and proceeded to trail it through the tarpon school; the result was electrifying. The fish could not be kept off it—it was instantly struck every time it touched the water and was responsible for hooking five fish, one of which stayed on three quarters of an hour and finally left us by the oyster reef route. Just after that another Wilson spoon was lost which left us with only one more chance. We decided to finesse this spoon with a maximum of dexterity, and therefore moved over to the south side of the battleground where there was deeper water. It was here that we hooked the only fish landed. When the battle was finished it was growing dark.

Items of Interest

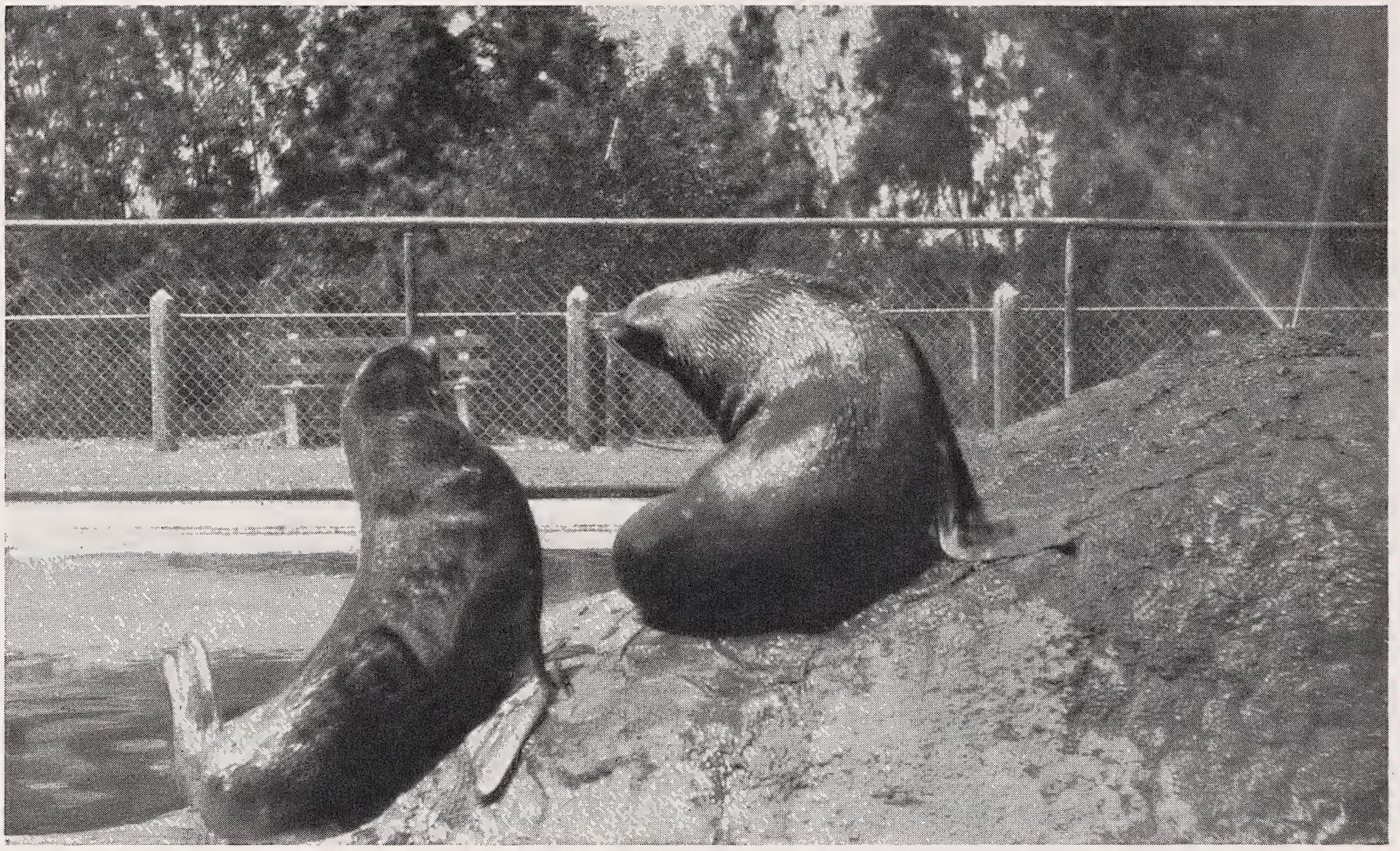
Sculptured Seahorses.—The sculpture showing two seahorses facing each other which now occupies the lunette over the entrance to the Aquarium was modeled by Gertrude Boyle.

It was cast in golden terra cotta through the generosity of Mr. Madison Grant and Mr. Devereux Forest Grant. A picture of the design was published in the January-February number of the BULLETIN.

Tropical Fishes—On September 14th Messrs. Breder and Shea returned from Key West, Florida, with an unusually varied collection of marine tropical fishes. There were 1,199 specimens of 70 species. Half of this collection was transshipped to the Belle Isle Aquarium of Detroit. By good fortune they just barely escaped the devastating hurricane, which at least would have ruined the collection.

New Fishes.—Dr. Homer Smith of New York University brought to the Aquarium some interesting fishes from northern Africa. Among them are a number of African lungfishes (*Protopterus*) which, with our South American lungfish (*Lepidosiren*), leaves but one form of this interesting group absent from our tanks. That is the Australian lungfish (*Neoceratodus*) which is the only other living representative of this ancient and peculiar group. He also brought a single *Polypterus*, a rare form, close to the line of evolution that lead to the higher vertebrates and finally man. This is the first time in the history of the institution that all the great group of fishes have been on exhibition at once.

Personal Services on the Expedition—The photographs presented in this Bulletin represent but a small proportion of those secured. Mr. Elwin R. Sanborn's camera work yielded many valuable views of the strange landscapes of Albemarle, Charles, Duncan and Chatham Islands. Mr. H. L. Gaddis not only made many useful photographs but acted as pay clerk in all dealings with the natives at Albemarle Island. He served with the expedition entirely at his own expense. Mr. R. De Sola being temporarily a member of the crew, received compensation from the ship. His services as interpreter have already been referred to. The excellent facilities afforded by the *Albatross II* were made available at all times by Captain G. W. Carlson.



Lower California Fur Seal (*Arctocephalus townsendi*) (Merriam) in San Diego Zoological Park, California. From a photograph by the San Diego Zoological Society, California.

REAPPEARANCE OF THE LOWER CALIFORNIA FUR SEAL

By CHARLES H. TOWNSEND

A FEW days before my arrival at San Diego, California, on May 4, 1928, the Zoological Garden in that city received from an island off Lower California two live male seals which Dr. H. M. Wegeforth, President of the San Diego Zoological Society, identified as the so-called Guadalupe Fur Seal (*Arctocephalus*). This identification I was at once able to confirm on seeing them, having in 1888 killed and preserved fur seals of this genus in the Straits of Magellan. This seal was described in 1892 by Merriam as *A. townsendi* from skulls I obtained at Guadalupe Island, off Lower California in May of that year. I had been sent there at the instance of the Department of State to procure and identify the fur seal formerly abundant on that island. It is now definitely known through the researches of Prof. E. C. Starks of Stanford University that the large numbers of fur seals formerly taken from the islands of central and southern California were of this genus and not Callorhinus to which genus the northern fur seal belongs. There are records available of the killing of more than 100,000 of these seals on islands of California and Lower California. The numbers taken of which records are not available, must have been vastly greater.

So far as known, Guadalupe Island was the last resort of this seal prior to its disappearance in the early 'nineties, several thousands having been taken there during the two preceding decades. The skulls in the United States National Museum and the two living examples in San Diego represent the only actual specimens known to science. The location of the small herd from which the San Diego seals were taken has for good reasons not been made public, but it was not Guadalupe Island.

Since the capture of these two fur seals it has been ascertained that the number now in existence is much greater than was supposed. It has spread over a wide area of coastal waters adjacent to some of its more ancient breeding grounds. Steps have been taken by the San Diego Zoological Society to

acquaint the Mexican government with the situation with the view to securing it from molestation on the rocks where it now breeds. The New York Zoological Society has presented the matter of its preservation in California waters to the United States Bureau of Fisheries and the Department of State. An opinion has been secured from the Assistant Secretary of State that our government might properly cooperate with that of Mexico for the preservation of this fur seal. It represents a resource in which both countries should be interested. These are records showing that 1,333 seal skins taken from Guadalupe Island in 1880 were sold in San Francisco at $15.00 each. There was at that time on the market a plentiful supply of skins of the more valuable northern fur seal.

THE FLIGHTLESS CORMORANT OF THE GALAPAGOS

By CHARLES HASKINS TOWNSEND

THE existence of this peculiar and large-sized bird remained unknown until twenty-one years ago. Although it has been taken several times since its discovery, it was completely overlooked by all the earlier expeditions to the Galapagos. It is the only cormorant known to the archipelago and has been found only on Narborough and the adjacent parts of Albemarle Islands.

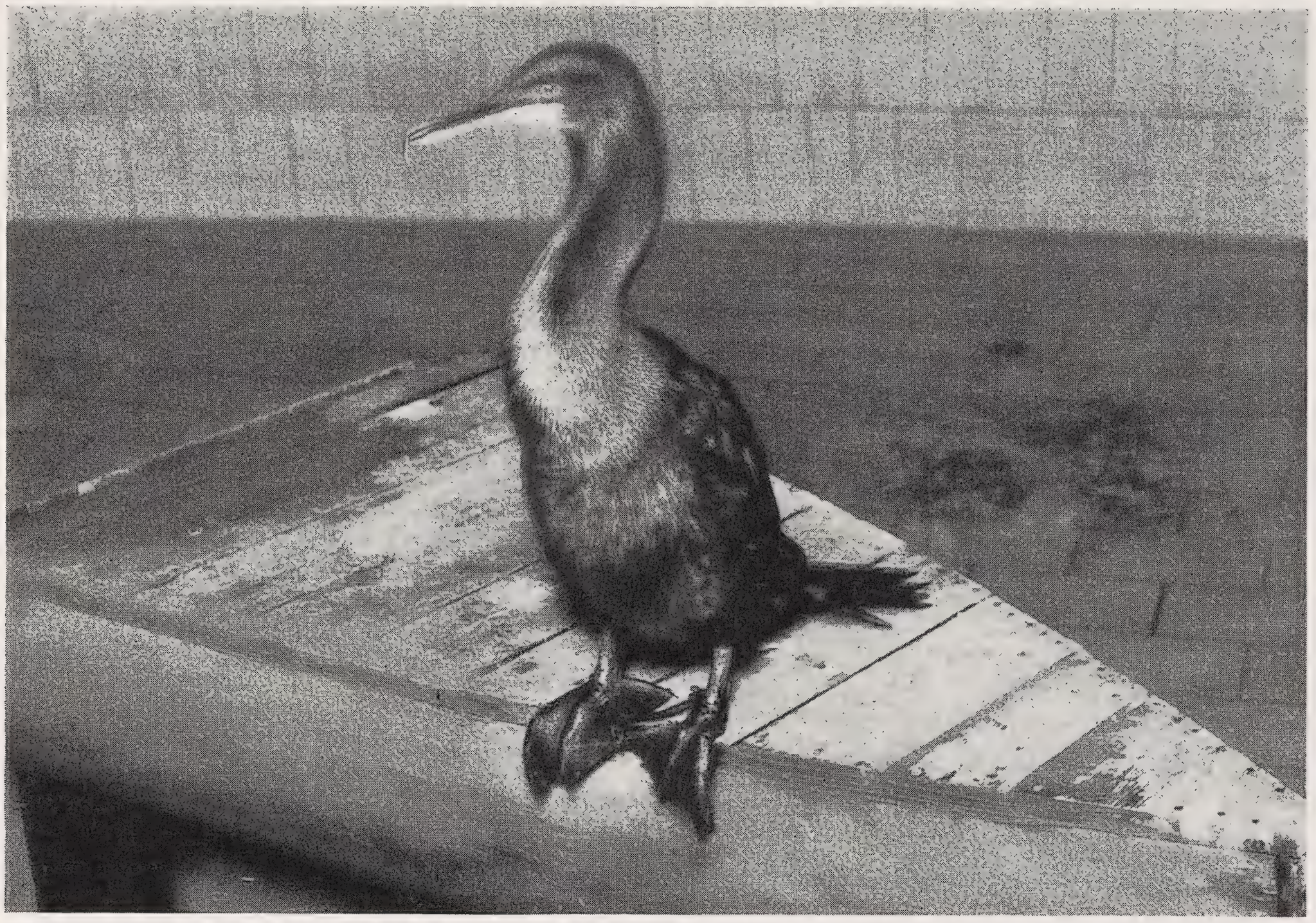
Looking, at least in the water, like other cormorants, the collectors of the earlier expeditions may have regarded it as one of the common mainland species and thereby missed a prize. That it escaped ornithologists so long is singular, as one of its few known nesting localities is in Tagus Cove, an anchorage visited by all Galapagos collectors.

It is probable that this cormorant was formerly distributed throughout the group, but being unable to fly has been destroyed by wild dogs which have long been very numerous. Its habit of nesting on the islands instead of on off-shore rocks as do most sea birds, may cause its extermination by dogs. These pests have not been reported on Narborough but abound on Albemarle. Nesting groups of cormorants are few and seldom contain more than half a dozen pairs and the birds are not sufficiently wary to seek refuge in the water when disturbed.

This cormorant and the marine iguana which shares its habitat, are outstanding examples among the peculiar animal forms indigenous to the Galapagos.

The first living examples to reach this or any other country, were those brought to New York by the Zoological Society's expedition of 1923. One of these did not survive long in the Zoological Park, possibly for lack of sea water to drink, as the first action of the survivor when sent to the Aquarium was to drink sea water. This bird was quarrelsome in the extreme and would soon have killed a Galapagos penguin brought by the same expedition, had it not been removed to another pool. After a few months it fell a victim to draughts during alterations in the building. Three flightless cormorants were received at the Aquarium in March, 1928, the gift of Mr. W. K. Vanderbilt who captured them on Albemarle Island. The species is known as *Nannopterum harrisi*. Its behavior in captivity is interesting.

After prolonged swimming in their pool, the birds stand upright in cormorant fashion and spread their abbreviated wings to dry much as a buzzard does on a sunny morning. The wings look as useless as they really are, the feathers being thin and scarcely touching each other when the wing is spread. When the bird swims or chases minnows under water the wings are closed against the body. While cormorant and penguin were living together it was interesting to see them moving under water with equal celerity, one depending entirely on its widely-webbed feet, the other entirely on its paddle-like wings. In watching the performance there was an added interest in recalling that the sole habitat of both was the same group of equatorial islands. The cormorant has no counterpart elsewhere and the penguin is the only representative of its family in the tropics.



The flightless cormorant (*Nannopterum harrisi*) of the Galapagos Islands, in the New York Aquarium. The Society is exhibiting several species of sea birds at the Aquarium with a marked degree of success. From a photograph by Morris Rosenfeld.

After feeding the birds seek their perches where they often sleep standing on one foot with the head laid diagonally across the back and the beak tucked under the wing feathers —not underneath the wing itself. In this position the eyes are not always covered by the feathers. One of the birds liberated in the office, soon hopped upon a box and thence to the window sill where it remained for hours, enjoying the sunshine, pruning its feathers or sleeping. Later while the cormorant was moving about the floor it suddenly found itself before a large mirror leaning against a radiator. Finding itself closely confronted with its image it jumped back with a loud squawk of surprise. This action was followed by a long inspection of the mirror, the bird raising its head high and gazing intently. When the mirror was shifted a little to one side the cormorant began looking about among some boxes apparently disconcerted by the disappearance of the bird it had seen. When it came again in line with the mirror and equally close, it shuffled back and squawked again. Here it remained stretching its neck, raising and lowering its head, but did not approach closer. It finally went to sleep without leaving the spot. The bird did not hesitate to jump from the height of an ordinary table and made a good landing on the floor. In the pool it can jump from one perch to another, a distance of one yard. It then walked to a live tortoise which it inspected and carefully touched with its beak. Later, hearing a few low croaking sounds, the bird was observed standing opposite the glass door of a book-case intently regarding its dimly reflected image. The flightless cormorant is a fighter, uses its sharply-hooked beak effectively and must be handled with gloves. When picked up it always squawks loudly. The weight of one of these birds on September 18 when apparently in good health was five and a half pounds.



Three flightless Galapagos cormorants (*Nannopterum harrisi*) presented to the New York Zoological Society by William K. Vanderbilt. Found only on Narborough and the adjacent parts of Albemarle Islands, this cormorant and the marine iguana which shares its habitat are outstanding examples among the peculiar animal forms indigenous solely to the Galapagos Archipelago.

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Arsinoïtherium, a rhinoceros-like ungulate of the Egyptian Oligocene, displayed a pair of great, bony horn-cores which were probably covered by a horny sheath. Lower figure shows skull of *Arsinoïtherium* (after Andrews). Copyrighted restoration by Charles R. Knight and reproduced here by permission of President Henry Fairfield Osborn, American Museum of Natural History.

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HORNS AND ANTLERS

THEIR EVOLUTION, OCCURRENCE AND FUNCTION IN THE MAMMALIA*

By H. E. ANTHONY

Curator, Department of Mammals of the World, American Museum of Natural History

Illustrations from photographs made in the Zoological Park unless otherwise noted.

PART I.

DEFINED in the broadest sense, horns are hard, excrescent growths upon the heads of mammals. This definition would include as horns all of the special outgrowths used for defense and offense (as well as those which have no utilitarian function), and associates the hollow horns of the cattle with the solid antlers of the deer. In a stricter sense, true horns are characterized by the following features; they are hollow, permanent and not shed during the lifetime of the animal, are unbranched, and are usually found in both sexes. In contradistinction, antlers are solid, deciduous (shed annually by the living animal), more often branched than simple, and usually worn only by males. An exception to the above definition of true horns is the horn of the American pronghorn which is hollow, deciduous, and branched. As further variants from the restricted definition might be cited the horns of the giraffe and of the rhinoceros, the former animal having low bony growths covered by soft skin and unmodified hair, the latter with a dense, formidable structure of specialized, agglutinated hairs. As an animal product, a horn is an epidermal structure, a hardened and thickened manifestation of the cuticle, of the same nature as claws, hoofs, nails, and the scales of the pangolin. An antler is true bone. It is the purpose of this article to single out some of the most interesting points in connection with these different types of growths upon the heads of mammals and to trace something of their evolution, occurrence, and function. The term "horn" will be used for all protrudent growths of an epidermal character, as distinguished from those structures of a bony nature which will be termed "antlers."

Apparently there has always existed on the part of mankind a great interest in the horns of animals. It is easy to discover the evidences of this interest in our English language. In the Century Dictionary there are no fewer than 179 definitions and compound words based upon the word "horn." We have expressions such as "to come out at the little end of the horn," "to pull in one's horns," "by the great horn spoon," "horn of plenty," et cetera. The debator manoeuvers to confront his adversary with a dilemma and asks him upon which of the two horns he wishes to impale himself.

Primitive man had a great respect for horns when worn by the living mammal and found a wide variety of uses for horns taken from dead animals. The larger bovines, among others, were dangerous adversaries because of horns, and the wearing of horns was synonymous with strength. It is a not uncommon attribute of pagan gods, the possession of horns, and various peoples represented one or more of their deities with horns. Jupiter Ammon is commonly figured with the horns of a ram. The Greek god Pan wore the horns of a goat. A copper statue head has recently

*The section of this account which deals with antlers will appear in the January-February number of the Bulletin.



Various details of the anatomy of horn and antler; 1. Longitudinal section through skull and horn-core of bighorn sheep. Note porous structure of core; 2. Longitudinal section through horn and horn-core of bighorn sheep; 3. Skull of pronghorn with horn sheath removed and placed to show relation to core; 4. Longitudinal sections through core and sheath of pronghorn; 5. Longitudinal section through horn of hartebeest. Note that the fundamental curves of the horn pattern are formed in the bony core; 6. Longitudinal section through an antler of a deer, showing solid, bony structure; 7. Longitudinal and cross-sections of horn of muskox showing heavy deposition of horn at base.

been discovered in excavations at Ur and is believed to be a godhead of the Chaldees. This head has a well-developed pair of bull horns. Even Satan, that more or less necessary figure of the Christian religion, is reputed to carry horns on his head. An interesting point in this connection is the similarity of Satan to so many of the heathen devils or gods of evil attributes which were also horned. According to some sources, the horns of Satan are those of a bull,* which is in keeping with a cloven hoof. The Tibetan god who has custody of the underworld wears a short pair of bull's horns. In the Swiss lake deposits have been found paired horns, made of clay, which

*Mr. Madison Grant, who kindly read this article in manuscript, wrote the author, regarding the type of horns worn by Satan, "the Devil is a lineal descendant of the great god Pan. He was the most popular god in Greece at the time of the introduction of Christianity. He was the chief of the Satyrs, who were one-half man and one-half goat, therefore, his horns were probably goat rather than oxen horns. However, that is a mere guess as I never have had an opportunity to study the skull, except as it was sculptured by Donatello."

Compare this with Charles Reade, in his book, *It is Never too Late to Mend,* "The god Pan colored black by the early Christians."

the anthropologists believe were used in some religious ceremony. The Swiss lake-dwellers lived about 5000 B. C., and this discovery of clay horns shows an early use of horns as significant objects. In the New World mythology one finds but little mention of horns, although there is a widespread belief in a great horned serpent, which crops out in the folklore of peoples from Canada to Peru.

Some of the halls of pagan times had antlers in the gables. These antlers were an architectural feature and probably in some highly conventionalized form could be found in occasional halls today. In Christian churches the corners or angles made by the ends of the altar are known as the gospel horn and the epistle horn.

Plates of buffalo horn were used by some of the savages of the Philippine Islands as armor. The plates were tied to one another in imitation of the steel armor of the Europeans and doubtless afforded considerable protection to the wearer.

The cornucopia represents abundance and is figured as an overflowing horn. This concept comes down from Greek mythology, from Amalthæa's horn, a goat horn, and the idea had its origin far back in the past. Another ancient concept attributed magical qualities to horns and there was a Hebrew belief that the ram's horn was especially potent. The walls of Jericho fell before the blowing of rams' horns.

In more recent times one encounters several interesting cases of the unusual use of horns. The Indians made a receptacle of horn in which to carry fire, storing it in tinder packed into the horn. In Utah and the adjacent territory they used the horn of the Rocky Mountain sheep to fashion agricultural implements. The Chinese made cricket cages out of horn or fashioned the cover out of horn if the cage was made of some other material. Even today they use rhinoceros horn, as well as antlers (especially in the velvet), to make medicine.* The women of western Mongolia have an elaborate method of dressing their hair whereby it is built up into two large horns in imitation of the great sheep of the Altai. In heraldry numerous horned mammals appear and not always has the herald known his natural history.

Warlike peoples wore horns as a head-dress when they went to war, according to the descriptions, written and pictorial, of the Babylonians, the Vikings, and barbarian peoples of northern Europe. The helmet of the Franks had metal horns projecting from it. Horns were used as material for bows, and as trumpets were sounded to command warriors. From this use of the horn as a wind instrument has developed the various musical instruments of brass and silver, called horns to this day.

The admiration for a splendid head of horns is widespread, and today sportsmen value their trophies in direct proportion to the horn development. This fondness for trophies is a reversion to mankind's early history. Any one fortunate enough to see unusually fine horns on a living mammal will feel an inner surge of admiration for the animal whether he has the trophy complex or not. It is an inherent response to a perfect, natural structure.

There is a very great diversity in shape, in size, and in the character of horns. Horns may be paired (the usual condition) or single, or be placed one behind the other along the midline; they may be straight and simple, curved and ringed or smooth, spiral and rugose, or bizarre and strikingly at variance with the popular concept of a horn. Horns may be a mark of sex, antlers almost invariably are, but among hollow-horned ruminants the females of many species have horns.

Hollow horns make their appearance early in the life of the individual. They arise as low, conical projections upon the frontal region and rapidly increase in height as the animal grows older. The farmer speaks of the budding horns of calves as "buttons," and they may be felt just under the skin. If rubbed with caustic soda when the calf is less than a week old, the horn growth is checked and the animal never develops horns. In very young calves the horn "button" has such a loose attachment to the frontal that it may be dissected from the skull and removed, with little inconvenience to the animal.

*Compare with the idea, prevalent in mediaeval times, that the horn of the unicorn was the most potent cure and test for all poisons.

The bony core, or *os cornu,* is hollow and the opening communicates with the sinus or cavity in the frontal element of the skull. The frontal develops a porous and reinforced structure whereby a double roof is formed over the brain, the upper one supported over the lower by numerous pillars and cross-members of bone. A blow to the outer wall will meet considerable crushing resistance before the vault over the brain is reached. As the *os cornu* increases in height, the horny covering keeps pace with it. The horny sheath is secreted by cells in the epidermis at the base of the horn structure and moves out away from the head through constant building up at the base. In the adult animals this growth still goes on, increase taking place basally, while wear tends to shorten the tips. The horn substance is nerveless and devoid of feeling just as is a fingernail, and the substance is biologically the same in both instances. After the rapid growth of the horn which characterizes the first years in the life of the individual, additional horn length is added more gradually, and the annual increase is a relatively small percentage of the total horn mass.

The horn-secreting cells are vigorously active and sometimes persist in putting out horns, in spite of attempts at discouragement. When adult cattle are dehorned, new horn growth will follow unless the skin about the base of the horn is cut away for a depth of one-quarter to half an inch. An unusual propensity of the epidermis for horn secretion occasionally appears in the case of mammals which are normally hornless. For example, there are records of horns on the heads of horses and on the heads of women. Sometimes these horns are paired in simulation of normal horns, in other cases there have been but single horns appearing in a region where no horn normally appears, as at the lower base of the ear or on the side of the neck. The substance secreted, however, looks to be horn and is hard and dense. The *Journal of Heredity,* 1917, page 434, reported a case of a woman who grew bilaterally symmetrical horns from her forehead; and on page 304 figured a cut showing a small curved horn growing out of the base of a horse's ear.

Domestic sheep display great variation in horn growth and may have from one to six horns. In the unicorn ram there are really two horns, but they have been induced, by malformation, to grow so close together as almost to coalesce along the midline and give the impression of a single heavy horn. Sheep with four horns are known from several localities, and occasionally this number is raised to five or even six.

Horns made their first appearance among the mammals at a remote geological time. Horned mammals are known from the Eocene and, by the Oligocene, members of several phyla were horned. Some of these early horns seem to have been similar to those of the present-day giraffe, merely protuberances covered with skin, but others were undoubtedly more complex structures and served as weapons. One can only surmise as to the appearance, when alive, of the horned mammals which are known today as fossils. We can be reasonably certain that some of them possessed grotesque horns. Judging from the bony cores, such mammals as *Syndyoceras* of the lower Miocene would occasion no little excitement in a zoological park of today. This creature had four horns, one pair over the eyes curving inward at the tips, and a second pair arising from the rostrum and curving outward.

The simplest type of horns to be found on living mammals is that of the giraffe. These are merely short, bony protuberances covered with soft, unmodified skin. The bony core of the giraffe horn begins its growth as a separate element and later becomes fused to the skull, attaching to the frontal and parietal elements, but showing the line of contact at an advanced age. In an old male giraffe the bony core may be three inches or more in diameter just above the base, and six inches or more in height. The skin covering this core contains blood vessels and does not differ from the skin on the rest of the head. A tuft of long hair is found on the horns of adult giraffes. The horns are paired and in the normal position. A median protuberance has been developed just anterior to the horns, but this can scarcely be termed a horn although it contains the possibilities for such a structure. The okapi, closely related to the



Giant Sable Antelope; The horns of this splendid animal constitute one of the finest trophies a sportsman may secure. The record measurement along the curve of the giant sable horn is sixty-four inches.



1

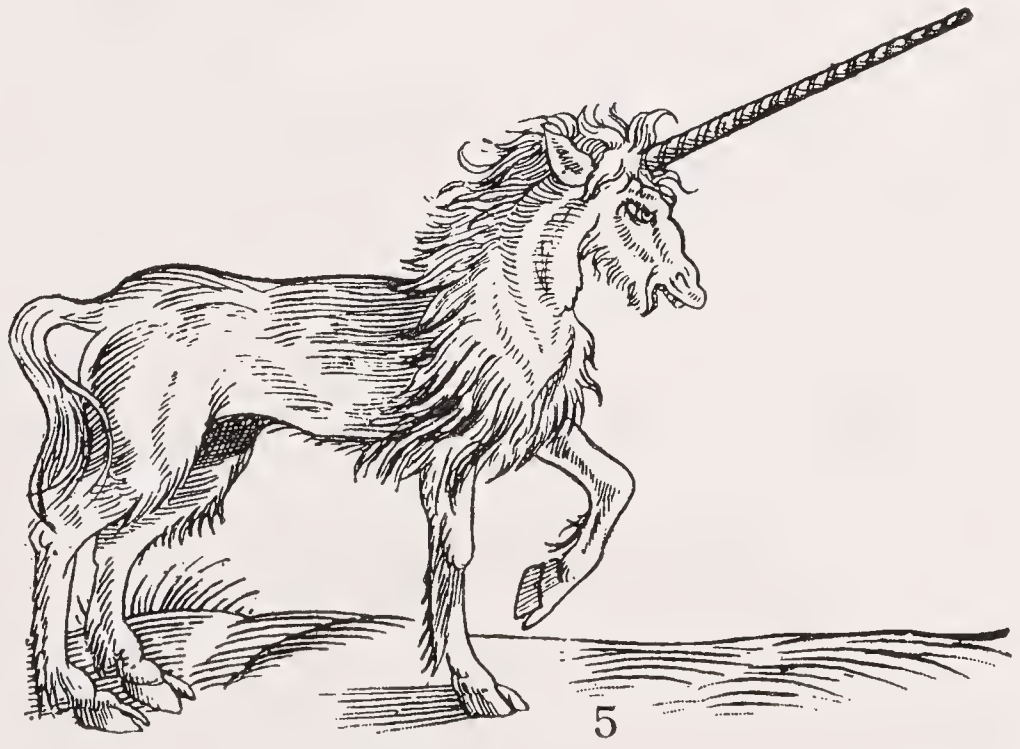
giraffe, has similar low, paired horns but lacks the median protuberance.

The giraffe horn represents a primitive, incipient type from which could be evolved the more complex structures found in the antelope, for example. This horn can have no value as a weapon of defense or offense, nor is it a manifestation of sex since females have it as well as males. The giraffe and okapi have the potentiality for horn development but, for some reason or other, have not carried the process beyond an early stage, or through long disuse have lost any earlier advanced development. The frontal bone of the giraffe shows great development of the sinuses and the whole upper structure of the skull seems designed to take care of shocks which might come upon the horns. This architecture provides a cushioned and reinforced horn base and argues for a function which the known facts of the giraffe life history tell us is never called into use. The inflated skull roof may be an inheritance from ancestors that used horns more vigorously than their descendants.



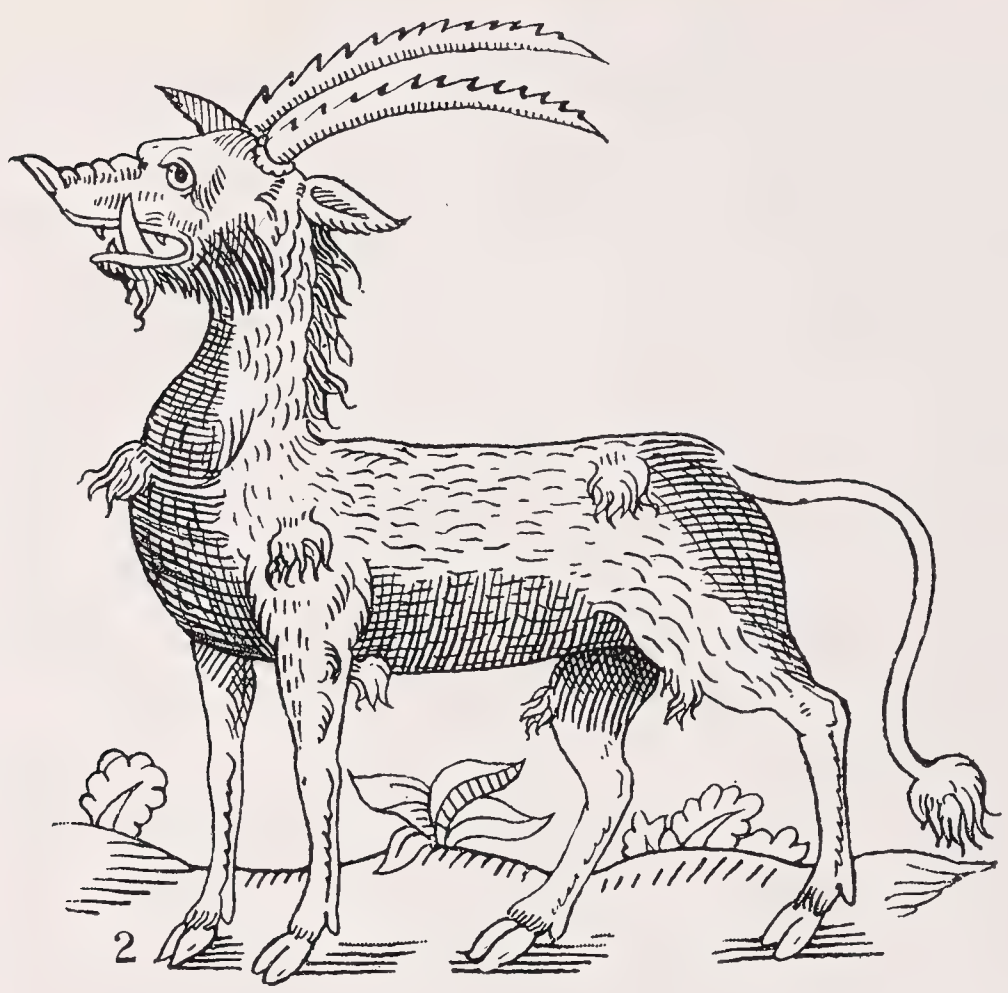
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Another simple type of horn, but one that has reached an advanced stage of efficiency as a weapon, is that of the rhinoceros. This horn is strictly a fabrication of materials derived from the epidermis, in effect it is made up of agglutinated hairs. The rhinoceros has lost the hair from most of its body, the skin being practically hairless, but on its rostrum the hairs have ceased to function solely as a covering, and matting together as fibers they have built up a dense, hard horn that is a very capable weapon. As a seat for the horn, a bony boss or thickening has developed upon the nasal elements of the skull. This boss does not represent a new structure in the skull but rather a growth increase of an element already present. There is no need for this bony base to increase in length and function as a hard core inside the horn, the substance of the horn is amply strong to serve without any stiffening structure. Needless to say, the rhinoceros horn contains no blood vessels or nerves and is incapable of sensation. The animal frequently wears grooves or furrows in its horns because of constant rubbing against grass and other vegetation, but this gives no pain to the rhinoceros. Under circumstances when a charging rhinoceros must be turned, if



5

Horned mammals in heraldry; 1 and 5. The unicorn (possibly the single-horned rhinoceros is the prototype of this fictitious beast); 3. Satyr. "Amongst the rest there is a beast called PAN; who in his head, face, horns, legs. . . . resembleth a Goat . . ." (Topsell).



2

possible without killing it, as when it is hunted with the camera, the usual recourse is to fire a bullet into the thick part of the horn near the base. The full shock of the bullet is delivered upon the head of the rhinoceros and it is dazed and bewildered. The bullet does not penetrate to a vital part, the horn being so tough that it checks the projectile, but the animal swerves from its course, and in a short space of time recovers from the experience.

Rhinoceros horns may be single or double; in living rhinoceroses they are never paired, but the second horn is placed on the midline near the first. The great Indian rhinoceros has a single horn. Some of the ancestral rhinoceroses had paired horns, but none of these have survived into recent times.

The titanotheres evolved horns that ranged from low, insignificant growths to a single great structure with paired lateral projections which were fused at the base on the midline. The titanothere horn at the peak of its development had more than a mere thickened boss of bone, the base of the horn rose in a tall, prolonged structure that may have played a part homologous with the horn-cores of modern bovines. The nature of the external covering of this bony mass is not known, but it seems most likely that the covering did not add materially to the height of the horns. It may have been unmodified skin or a tough horny covering; it almost certainly was not like the horn of a living rhinoceros.

It has been stated earlier in this account that the horns of most mammals are carried upon the frontal bones of the skull, but this is not invariably the case. Modern hollow-horned mammals all possess frontal horns, but fossil types show that other elements of the skull have possessed the faculty for horn growth. The position of the titanothere horn varied somewhat but was in the rostral region. The uintatheres showed an accelerated capacity for horn growth in developing no less than three pairs of bony cores or horn bosses, a posterior pair over the occiput, a middle pair over the eyes, and an anterior pair on the end of the rostrum. The foremost pair of these may have carried an epidermal horn like that of the rhinoceros, the others probably were covered with unmodified skin. The present-day rhinoceroses carry the single or double horn upon



4



6

Horned mammals in heraldry; 2. Heraldic antelope, said to cut down small trees with its saw-like horns; 4. Musimon or Tityrus. A fabulous cross between goat and ram; 6. A variant of No. 2, with tusk growing from nose.





The horns of the giraffe (right) and those of the okapi (left) are alike in being but low bony projections clothed in undifferentiated skin.



The median projection just anterior to the paired horns of the giraffe is sometimes termed a horn. Although it may be a conspicuous mound, it scarcely qualifies as a horn in its present state of development.

the midline of the rostrum; some of the fossil ancestors had paired horns, but they too were situated upon the nasal bones. Some of the toxodonts were horned, a single, median, rhinoceros-like horn above the eyes, and in the lower Pliocene of Nebraska has been found a horned, gopher-like mammal, *Epigaulus*, which carried a pair of horns just anterior to the eyes. Thus it can be noted that, at different stages of their evolution, many phyla of mammals have demonstrated a capacity for horn growth, and this function has not been restricted to any single element of the skull nor confined to any given area of epidermis.

In general, it accords with the known facts to assert that all of the known hollow horns are outgrowths upon the frontal bones, while those horns which are carried upon elements anterior to the frontals are either solid epidermal structures, like the rhinoceros horn, or elevated bony cores covered by undifferentiated epidermis like the giraffe horn (this latter is carried by the frontal bone, however).

Our North American pronghorn carries horns which are peculiar in two respects. The horn sheaths are like those of the cattle and the antelopes, hollow, but unlike them in that they are shed annually. The second distinction lies in the fact that the pronghorn horn is branched, the only hollow horn known to be forked. This horn sheath is secreted by epidermal cells the same as among the antelopes, but once a year the sheath drops off, its place to be taken by a new growth. The new sheath is formed first at the tip and moves down (the reverse of the condition in other hollow horns) and is partially complete before the old horn drops off. The pressure of the newly formed horn loosens and forces the old horn from the core. The pronghorn serves as a connecting link between the deer and the bovidae as regards the growth of horn. When the pronghorn sheds, it loses only the epidermal covering which is comparable to the velvet which the deer rubs from its hardened antlers. The deer also may be said to shed its horn sheath, the velvet, but it carries the shedding process to the ultimate limit when it later drops its antler, which corresponds to the bony horn-core of the pronghorn and the antelope.

Among the hollow horns the simplest are the short, straight spikes of the smaller antelopes, such as the pigmy antelopes and the duikers. This type of horn varies among these animals from a length of about two inches (*Nesotragus*) to some four or five inches (*Ourebia* and *Sylvicapra*). Often these small horns are almost hidden in the hair of the head, and while they may serve as weapons of offense when the bucks fight one another, they probably have but little value as a defense against predatory animals. Among these small antelope the males, as a rule, are horned, the females not, there being a few exceptions where both sexes carry horns (bush duikers and some of the klipspringers). These small horns may be nearly smooth throughout their length, or ringed at the base; or they may be circular in cross-section, triangular, or flattened.

The horn of the domestic cow represents a simple, generalized structure which occurs as well among wild types. Most of the strains of European domesticated cattle have been derived from the European wild ox or aurochs. The aurochs had large horns approximately cylindrical and fairly smooth without any of the massive basal development which characterizes many of the wild oxen. The banting of southern Asia has horns very much like those of the barnyard cow, not only in shape but in details of texture and surface. The horns of domestic cattle have shown themselves to be a very variable feature, for we have a range from the short, recurved, common type through intermediate stages to the great, massive horns of the Gondokoro ox or the broad, widespread horns of the Texas steer. A great deal of this variation in the horns of domestic cattle, all of it in fact as far as it occurs in strains of European tame cattle, is the result of selection working on a single species. Such great variety demonstrates the capability of the animal to develop different types of horn growth and helps to explain the condition existing among the wild cattle.

The horns of wild cattle show a tendency to develop mass. There are instances, such



The great Indian rhinoceros (above) has but a single horn which never attains the extreme dimensions of the anterior horn carried by its African relative, the so-called white rhinoceros or square-mouthed rhinoceros (below). A maximum length of 62 inches has been recorded for this horn of the white rhinoceros. The posterior horn is always much the smaller and seems to be on the way to obsolescence. On rare occasions a white rhinoceros is noted as having no posterior horn. The longest anterior horns are found on the females.

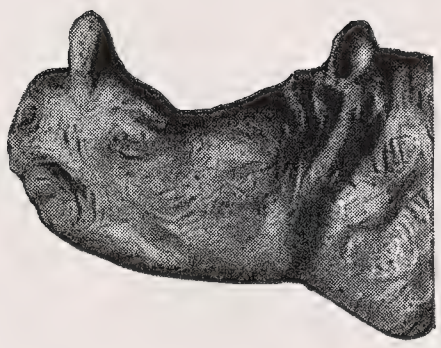




Two stages in the growth of the rhinoceros horns. The upper photograph shows an immature stage of the same individual figure below, an African black rhinoceros. On the young rhinoceros the horns appear as low buds and early assume the character and appearance of the adult horns, differing from them only in the matter of size.



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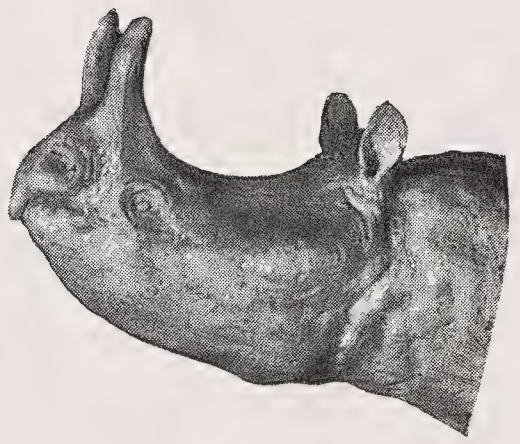
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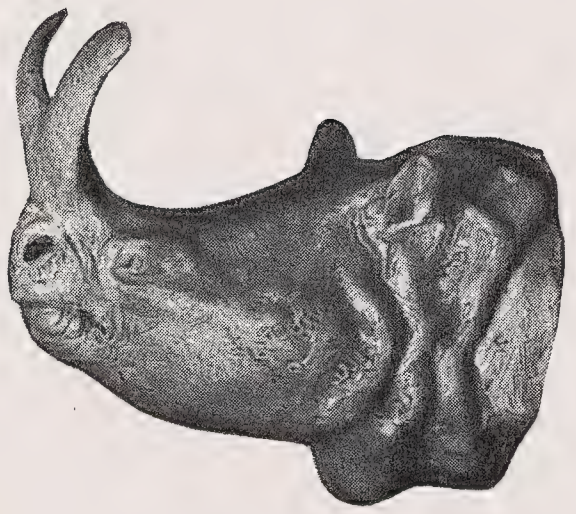
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Series of models of titanotheres, showing various types of horns; 1, 2, 3. *Megacerops;* 4, 5, 6. *Titanotherium;* 7, 8, 9. *Symborodon;* 10, 11, 12. *Brontotherium.* Models by Erwin S. Christman. Reproduced by permission of President Henry Fairfield Osborn, American Museum of Natural History.



The titanotheres are a group of perissodactyls (odd-toed ungulates) that flourished in Eocene and Oligocene times. The height of horn development for the group was reached by *Brontotherium,* shown in the restoration, and this development resulted in a broad pair of nasal horns united at the base. Copyrighted. Restoration by Charles R. Knight and reproduced here by permission of President Henry Fairfield Osborn, American Museum of Natural History.

as the anoa, of cattle with horns small in proportion to their body size, but even here the horns are robust and by no means weak. The ox horn may build up mass at the base, as in the case of the African buffalo or the muskox. Here the growth of horn substance is so heavy and thick that it is capable of stopping a bullet, and the entire crown of the head (males) is protected by the expanded sheath of tough material. The horns of these animals terminate in sharp, tapered points and the entire structure is one of great strength, with the mass where it is most needed mechanically. Such horns are terrible weapons and in the case of the African buffalo have given their possessor the reputation of being one of the world's most dangerous mammals.

In other species of wild cattle the horn mass is not concentrated into a frontlet but is more or less evenly distributed throughout the entire length. Horns of this type are carried by the yak and by the Indian buffalo, those of the latter animal being especially heavy and massive.

The oxen, with the exception of the muskox, all have horns nearly straight or with simple curves. The muskox horn is strongly recurved. In all the species the points of the horns project upward and are so arranged that they have marked efficiency as weapons. The bony cores are sturdy processes on the frontal elements of the skull and the whole architecture of the skull is designed to carry the shocks and strains to which these projections may be subjected. The weight of the horns is so great that the muscles which hold up the head must needs be correspondingly developed and the nuchal ligament is a great heavy band. This ligament is of good size in all horned mammals but especially so in the oxen.

The horn of the ox has been of very considerable service and played a large part in the life of early man. From the unaltered horn sheath he made drinking cups, ladles, trumpets, and containers such as powder horns. From the flattened sheath after splitting he constructed spoons and similar small objects. The Chinese made beautiful lanterns from ox horn. They soaked the horn in water for several weeks, split it into thin sheets, and joined the pieces so cleverly that the joints are nearly invisible. The material of such a lantern is almost transparent and sufficiently translucent to pass considerable light.

The greatest variety in horns is displayed by the antelopes as a group, not only in mere size but in the shape of these structures. The greater number of antelope species have horns which are either the generalized straight or backward curving patterns or some simple modification of them. One species, the four-horned antelope, as its name implies, has four horns. The gemsbuck illustrates the straight type of horn, the leucoryx the curving type. The straight horn may be modified by twisting about the long axis, as in the eland, or by open spiral curving, as in the koodoo; the simple curved horn is modified in a great number of ways. The tips of the curved horn are evenly divergent in the waterbuck, abruptly divergent in some of the reedbucks, or convergent in some of the gazelles; the tips may incline forward, be projected backward in the plane of the face or drop much below it. The curve traced by the horns varies from the simple arc in a single plane to a lyriform figure in several planes. In the great majority of species these curves are graceful and not abrupt.

Some of the antelope, however, possess horns that seem to have evolved along fantastic lines. Such horns are found among the hartebeests and the gnus. In both groups the more generalized horn is to be found and the deviation from this type is to be seen on the more specialized species. Doubtless these variant horns are as serviceable to their owners as the more simple horns, but because they change direction so abruptly or curve forward where one expects a curve in the other direction, they look bizarre and strange to us.

In some respects the horns of the wild sheep show the finest horn development to be seen in the entire mammal kingdom. The great curling horns of Marco Polo's sheep or of our Rocky Mountain bighorn are, in proportion to the body size of the animals themselves, the largest and heaviest of mammal horns. The Himalayan ibex alone can stand comparison with these sheep. But not all of





The American pronghorn, *Antilocapra americana,* is the only hollow-horned mammal that sheds its horns. The horn sheath is annually replaced by a new growth, the old sheath dropping off in response to pressure from the growing sheath under it or as the result of some slight knock or external disturbance. The horn of this mammal is also unique in being forked, the only hollow horn that is not a simple, undivided projection.



Sivatherium, found in the lower Pliocene of Asia, has been classified with the family containing the giraffes. Its horn-cores present certain peculiarities which indicate that the posterior, branched pair were similar in their nature to those of the American pronghorn and the anterior pair were possibly of the normal hollow-horned type. Sketch taken from Murie's restoration.

the sheep horns are thus enormously developed; among these animals we find again the same wide range of variation seen in other groups.

Among the sheep both sexes are generally horned, but there is a great sexual disparity in size and pattern. The horns of the ewes are much smaller than those of the rams and, with one exception, invariably are nearly straight or but slightly curved, in contradistinction to the curved or spiral appendages of their mates. Furthermore, the ewe horn is slightly to moderately rugose, while the ram horn is usually heavily ringed with deep ridges.

The bharal or so-called blue sheep, regarded by some as on the border line between the sheep and the goats, displays a type of horn comparatively simple for the sheep. It is strongly curved but does not drop down past the head in a close spiral nor is it deeply scored by surface markings. The typical sheep horn constantly changes direction and the tip, in the case of old males, may have generated in its growth considerably more than a complete circle.

As a weapon the sheep horn does not depend upon a piercing point, but rather upon a crushing frontal attack where mass is the important factor. The ram lowers its head and charges directly home without any upward thrust of the horns. This method of attack has so impressed early man that he has transferred the name of the animal onto the act. His device for knocking down a wall was a battering ram, and in early times the effigy of a ram's head was carried on the front end of this engine of destruction. The combat





The upper figure shows the bony horn-cores of *Bison latifrons,* a gigantic Pleistocene bison which had a horn spread of six feet or more.

The two lower figures are of the Texas longhorn steer and show two distinct horn patterns. The horns of the lowest head on this page measure more than six feet from tip to tip.



Two very distinct types of wild ox horn. The African buffalo horns (upper figure) are massive at the base (especially on males) and nearly meet on the midline, while those of the banting (lower figure) are widely separated at the base. There is, however, a sturdy band of tough horny substance lying across the crown from horn to horn of the banting, and this may have somewhat the same function as the heavy frontlet of the buffalo. The horns of the banting are very like those of the domestic cow in form.

of two rams is sufficiently impressive that no one who has seen it will wonder how our ancestors came to think of the battering ram. Near Antisana, in the high Andes of Ecuador, a flock of domestic sheep was kept for the night in a stone corral. Every morning as the sheep left the corral, I saw the rams engaged in combat, each ram against his neighbor or against several neighbors. A series of individual contests took place, the rams meeting head on at the end of a spirited charge of fifty feet or more, and the crash of horn against horn could be heard for a mile or more. The marvel of it was that living tissue could withstand such frequent and heavy concussions.

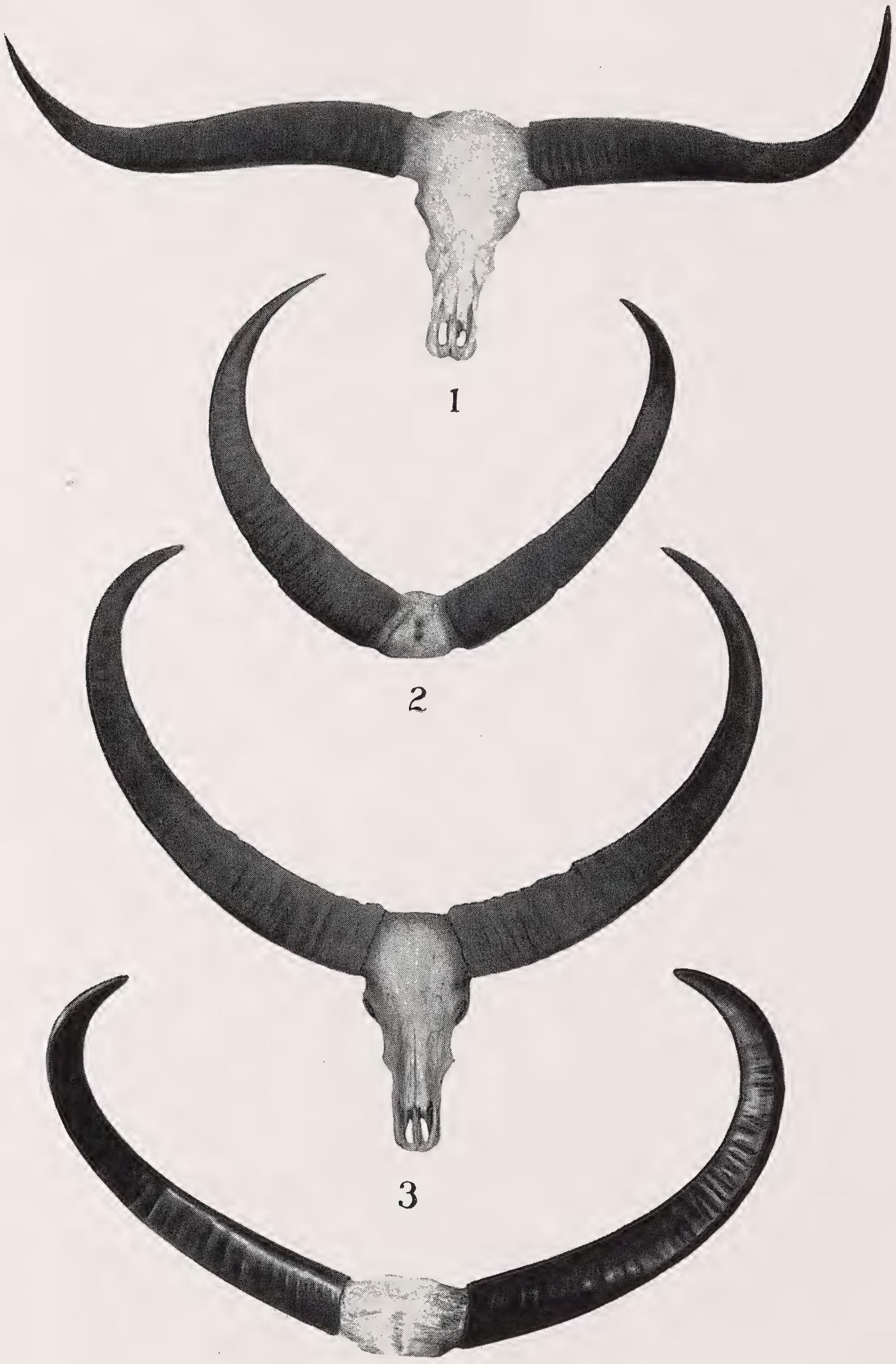
It has sometimes been stated that the bighorn sheep uses its heavy horns to break a fall, that it leaps and lands upon its head. Such an idea is, of course, fallacious. The horns of these sheep are frequently broken at the tips and otherwise show severe wear, but this is not due to deliberate head dives. Some of the attrition is the result of fighting, and part of it is due to the rubbing and knocking the horns unavoidably receive in the normal activity of the animal. The very large horns often are of such a shape that it is difficult for the sheep to put its mouth to the ground. The head may not be tilted sideways, for the huge curl of the horn will strike the earth. When feeding among the rocks, such an animal would be continually handicapped by its horns.

The horns of the wild goats have developed along rather different lines from those followed by the wild sheep. The goat horn in its finest expression runs to length and does not lose this effective length by tightening up into a spiral. The great sweeping horns of the ibex or the tall, twisted horns of the markhor are in marked contrast to the horns of the argali which may equal or exceed them in actual length along the curve of the horn but close up in a spiral that leaves the point relatively near to the head.

Most of the wild goats have rather imposing horns. The tahrs, belonging to a genus, *Hemitragus,* very close to the genus *Capra* which contains the goats, have somewhat insignificant horns, proportionally robust and heavy but short. Between the tahr horn and the true goat horn there is quite a gap, for the smallest-horned species of the genus *Capra* have horns more than twice as long. Great size and majesty of bearing characterize the wild goat head, and it is interesting to note that these qualities are conveyed by several very distinct types of horn development. The ibex horn is the more primitive and generalized type of goat horn and is the logical development from the short, simple horn seen on so many of the hollow-horned ungulates. It has reached the peak of its development, however, and is about as large as can be carried by the animal. In sheer size, symmetry of curving outline, and vigorous robustness of growth, it marks a supreme evolution. No one can see an ibex in its native haunt without feeling unbounded admiration for such a splendidly-horned creature. When a male ibex cuts the sky-line on some distant rocky ridge, the unmistakable profile of those scimitar-shaped horns can be seen for miles.

The markhor, on the other hand, has evolved a type of horn which is not only impressive because of mere physical size, but unusual in the manner in which the horn is twisted or rotates about its long axis as it grows. The closeness of this long spiral is variable and there are two principal types of markhor, one, the Astor markhor, with horns which have an open twist not exceeding one and a half turns, the other, the Suleman markhor, with a tighter spiral which may attain three or more complete turns. Between these two types are other subspecies which have horns intermediate in character. In passing, it might be noted that the twist of the goat horn is the reverse of that of the sheep horn. The horn of a bighorn ram curls to the right (on the right side of the head, to the left on the left side of the head); the horn of the markhor twists to the left (considered in the same manner).

The subject of the function of horns is one that might be provocative of much argument. There can be little doubt of their function in many cases. It is obvious that the horns of the African buffalo are efficient weapons. It is, perhaps, equally apparent that the horns of the sheep and goats, so much larger on the



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Various types of Indian buffalo horns; 1, 3, and 4 are Indian buffalo from the continent of Asia; figure 2 is a wild carabao, or water buffalo (Indian buffalo) from the Philippine Islands.


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Four distinct types of wild ox horns; 1. African buffalo, with massive horns, the tips curving above the main body of the horns; 2. Muskox, with horns built up at base as in the African buffalo, but with the tips dropped much below the main body of the horns; 3. American bison, with short, simple horns and no horny frontlet; 4. Yak, with simple horns which curve widely from sides of head and do not approximate at base.



Horns of wild oxen; 1, 4, 5. American bison, bulls; 2, 3. American bison, cows; 6, 8, 11, 15, 20. African buffalo; 7, 17. Indian buffalo; 9. Gaur; 10. Yak; 12, 14. Tamarau; 13. Banting; 16. Anoa; 18. Gayal; 19. Congo buffalo; 21. Senegambian buffalo; 22. Wood bison.

All figures to the same scale.



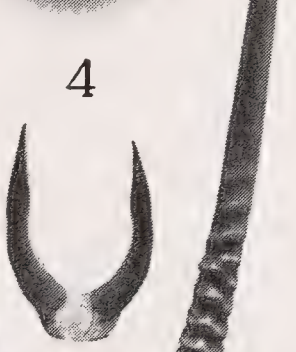
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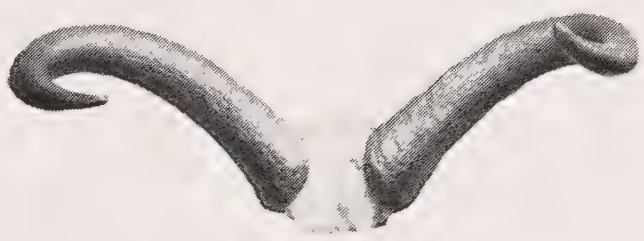
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Various types of antelope horns; 1. Roan antelope; 2. Springbuck; 3. Sable antelope; 4. Eland; 5. Harnessed bushbuck; 6. Beisa; 7. Gemsbuck; 8. Grant gazelle; 9. Lesser koodoo; 10. Greater koodoo; 11. Impalla; 12. Tora hartebeest; 13. Hunter antelope; 14. Lichtenstein hartebeest; 15, Brindled gnu; 16. Jackson hartebeest.

All figures to the same scale.



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Heads of African antelope; 1. Addra gazelle, male; 2. Dorcas gazelle; 3. Grant gazelle, female; 4. Common waterbuck; 5. White-eared kob; 6. Grant gazelle, male; 7. Coke hartebeest; 8. Red-fronted gazelle; 9. Dorcas gazelle; 10. Thomson gazelle; 11. Addra gazelle, female.

All figures to the same scale.



Contrasted types of antelope horns. The waterbuck (upper left) with simple horns having slightly inturned tips; the lechwe (lower left) with strongly outturned tips; the gnu (upper right) with horns sharply recurved and tips anterior to the bases; and the tiang (lower right) with horns curving gently and tips much posterior to the bases.

males than on the females, are, in part at least, secondary sex characters and not as important in the animal's contact with other species as against their own kind. The horns of the giraffe are neither weapons nor sex characters. But there are plenty of instances where one may wonder what useful function the horns may serve, what law governs the appearance or non-appearance with regard to sex, or what controlling mechanism permits some mammals to grow large horns while other mammals, with apparently an equal need of large horns, must get along with much smaller ones.

It has been noted that all of the wild cattle have horns. The horns of the females are usually noticeably smaller than those of the males and in some cases, muskox and African buffalo, the horns are farther apart at the base, without such a strong frontlet, but nevertheless are functional as weapons of defense. Where the cattle are gregarious in habit, the prevailing trait in this group, the bulls normally take up the defense of the flock and their larger horns are useful for group protection. Nevertheless, a cow by herself is able to put up a good defense under conditions of equal combat and may, upon occasion, be more aggressive than a bull. Since the bulls fight among themselves to a greater or lesser extent, the size of their horns has probably been influenced to a considerable degree by the forces which develop secondary sex characters.

Wild sheep and goats live in an environment where flight usually is a better recourse than resistance. While the males have such large horns that they might well impose respect upon most predatory animals, the females have small horns and the best interests of the flock counsel flight into the inaccessible crags where enemies can not follow. Also the ram method of attack, while effective if the enemy can be knocked off a cliff or cornered where a crushing blow can be fairly given, is not as disabling, under most circumstances, as the impaling thrust of the bull. The larger horns of the male sheep and goat show by their nature (differing in pattern from the female), by correlated sexual characters (beards on male goats, long hair fringe on throat and chest of male Barbary sheep), and by the domination of the prime males that the greater part of the excessive horn development is to be attributed to the manifestation of sex.

In the case of the antelopes, practically all of the larger species are possessed of horns which serve as media of defense. Animals such as the roan antelope, the sable, the oryx, and the gnu may even become aggressive and use their horns for offensive purposes, and for this the horns are well suited. The females of these species have horns as well as the males and there is little sexual differentiation. Indeed, the female oryx has longer horns than the male and seemingly a good case might be made out for a strictly utilitarian function of the oryx horns. The demeanor of these antelopes shows that they know they are armed and that they do not carry horns for ornamental purposes.

In contrast to these examples there are the waterbucks, kobs, koodoos, and bushbucks only the males of which are horned. While these horns are of large size and serve the males as weapons, the females are defenseless against beasts of prey and one is forced to the conclusion that, in such cases as these, horns have been developed as secondary sex characters, the province of the male, destined to excite the admiration of the females (perhaps) and to wage combat against their own kind, but otherwise not necessary to the preservation of the species.

With the smaller antelopes it is doubtful that the presence or absence of horns is a really vital matter. These mammals are all timid and flee at the first hint of danger, relying on keenness of vision, scent, or hearing, and shunning contact with an enemy. The females that are hornless seem to survive the struggle for existence equally as well as those that are horned. Although the horns could serve as weapons of defense against predatory mammals, most of the victims are captured by stealth and have no opportunity to use them, the small size of the antelopes rendering them helpless to prolong the struggle.

It would seem that certain of the mammals have inherent possibilities for bearing horns.

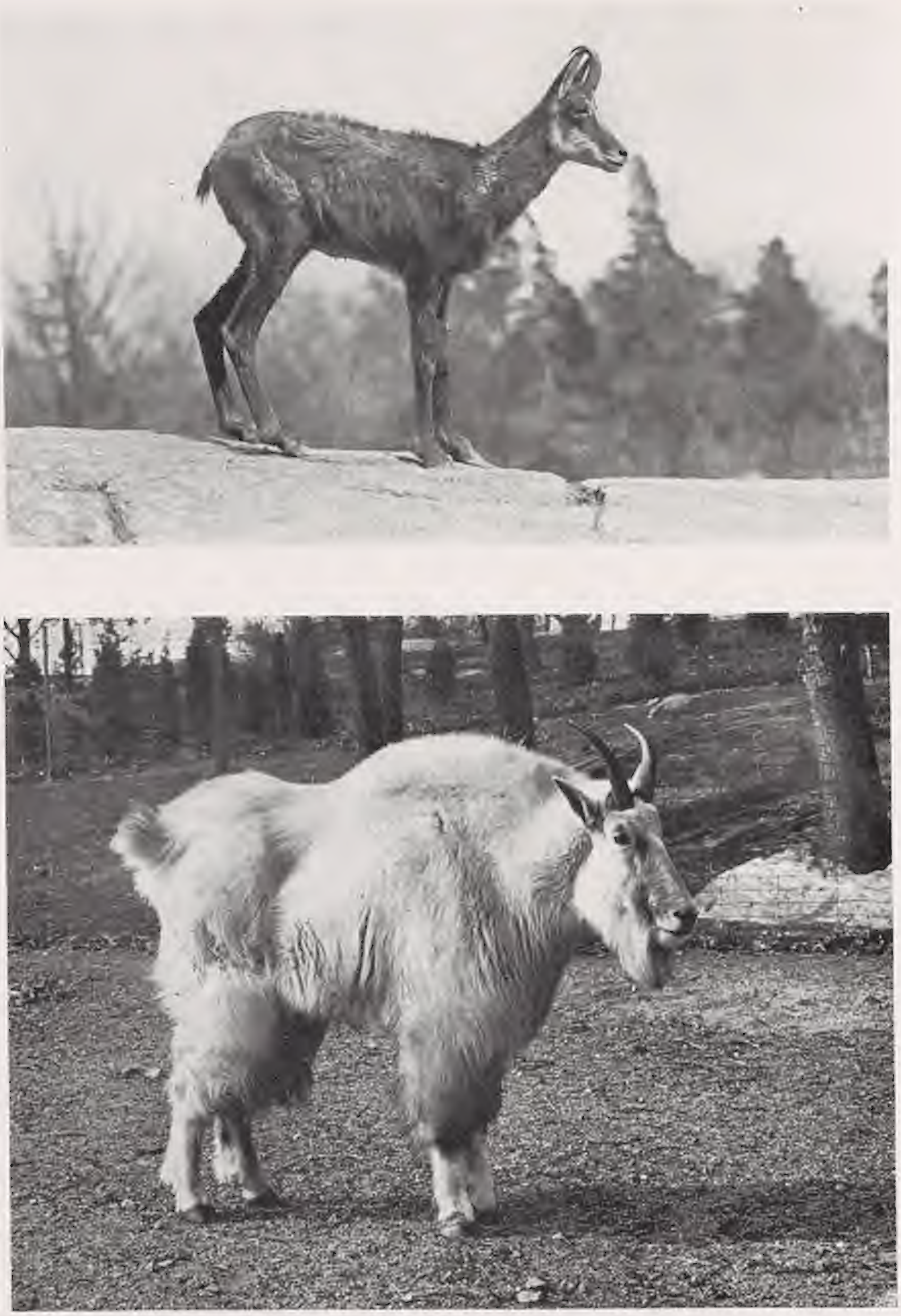




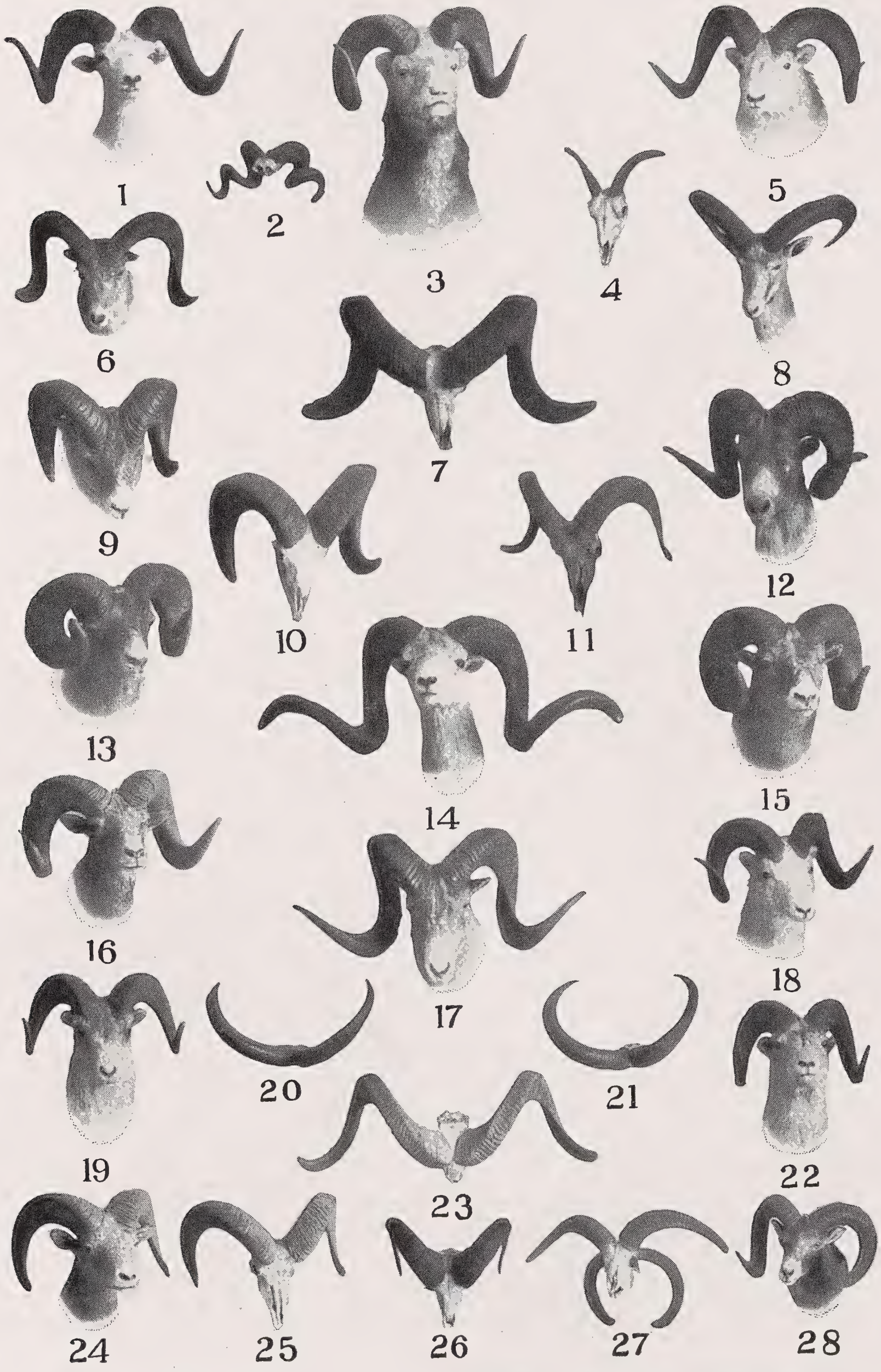
The bongo (right) is a forest-dwelling antelope with heavy horns the tips of which are noticeably light colored. The horn is twisted about its long axis. The inyala (left) is related to the bongo and shows this relationship in the same type of twisted, yellow-tipped horn, although differing noticeably in many external characters such as the ear.



The height of development in the long, open-spiral horn is reached by the greater koodoo. The record measurement for a male greater koodoo is 71.5 inches along the curve of the horn.



The chamois (above) and the white or Rocky Mountain goat (below), its American relative, are members of a small group of mountain antelopes. The horns of the members of this group are simple and small in proportion to the body size of the animals. It can not be argued that such small horns are a necessity for cliff and mountain climbing, for the mountain sheep and ibex carry massive, heavy horns over the roughest terrain.



Horns of various sheep; 1, 5, 18, 22. Dall mountain sheep; 2, 27. Domestic sheep; 3, 19. Stone's mountain sheep; 4, 9, 13, 15, 24. Rocky Mountain sheep; 6. Turkestan mountain sheep; 7. Siberian argali; 8. Ladak urial; 10, 12. Tibetan argali; 11, 26. Kamchatka mountain sheep; 14. Marco Polo sheep; 16. Lower California mountain sheep; 17. Littledale mountain sheep; 20, 21. Aoudad or Barbary sheep; 23. Karelin mountain sheep; 25. Mexican mountain sheep; 28. Sardinian mouflon.

All figures to the same scale.









Heads of mountain sheep or bighorn sheep; *Upper left.* Rocky Mountain sheep or Rocky Mountain bighorn; *Upper right.* Littledale mountain sheep or Littledale argali; *Lower left.* Dall mountain sheep or Dall white sheep; *Lower right.* Stone's mountain sheep or Black mountain sheep.



Bharal, or blue sheep, an aberrant member of the sheep group with horns which do not curl and are relatively smooth. Compare with bighorn sheep, typical wild sheep with massive, corrugated horns that curl in a close lateral spiral, on the opposite page.

The mechanism for horn growth is the same for all of the hollow-horned types. These possibilities have been handed down from ancestral forms which we know today as fossils. In some of the mammals the capacity for horn development has received an advanced degree of expression, in others it has remained more nearly dormant. Not only has this expression taken the direction of increase in size, but it has sought for other outlets and has evolved patterns which appear to us to be fantastic and unnecessary. That is to say, if a simple, straight or curving horn, such as that of the oryx or the sable antelope, was found to be successful by the antelope organism, it is difficult to understand why the direction of growth should be so changed to produce the specialized hartebeest horn. One possible explanation is that the propensity for hornedness has been sufficiently flexible to permit these variations from the generalized horn type to start, and once begun the deviation from type has not been a handicap in the struggle for existence. While it is true that there are often several ways of accomplishing a given end, it is equally true that one of these ways will usually be the best. There has apparently either been no best type of horn, or else horns have not played as important a part in the vital existence of mammals as one might imagine.

The prevalence of horns among the mammalia, their persistence through several geological epochs, and their parallel evolution in different phyla all argue for the importance of these structures. Whether we can understand and give logical reasons for what appear to be inconsistencies in the scheme of horns, or whether we believe that all such structures are teleological and created for a predestined purpose or in response to a definite need, we can rest in accord on one point, namely, that the horns of mammals are marvelous and splendid structures. The more we see and learn of horns, the more we must respect the infinite capacity which Nature displays in creating such a wide variety of splendid accessory growths.



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Horns of ibex, markhor and takin; 1. Arabian ibex; 2. Persian wild goat; 3. Suleman markhor; 4. Siberian ibex; 5. Takin (a goat-like antelope belonging in the group with the chamois and Rocky Mountain goat); 6. Himalayan ibex.

All figures to the same scale.



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Horns of wild goats and goat-like mountain antelopes; 1, 5, 6, 7, 8, 10, 12. Various species of ibex; 2. Suleman markhor; 3, 13. Old World wild goats; 4. Astor markhor; 9, 18. Serow; 11. Chamois; 14, 24. Takin; 15, 23. Goral; 16. Tur; 17. Chitral markhor; 19, 20, 22. Tahr; 21. Rocky Mountain goat.

All figures to the same scale.



Suleman markhor (upper right); Himalayan ibex (center); and aoudad, or Barbary sheep (lower left).

The wild sheep lack the long beard seen on the wild goats, and the only sheep with a special development of long hair is the aoudad. The beard of the goat is a secondary sex character, found on the males only, but the aoudad fringe is almost as long on the females as the males and hence is not purely a sex character. The horns of the male aoudad do not greatly exceed in size those of the females. Seem-



Female tahr with young (upper left); Himalayan ibex (center); and Spanish ibex (lower right).

ingly, among the other wild sheep the mechanism for sex manifestations has sufficient expression in the super-development of the massive horns of the rams and has not sought an outlet in the growth of a beard or similar hirsute adornment.



Above. Protoceras, found in the North American Oligocene, the males of which have two pairs of low, horn-like protuberances. This animal was a traguloid, distantly related to the deer and to the giraffe. *Below. Uintatherium,* of the middle Eocene, was a primitive amblypod ungulate that shows an extreme development of the low, skin-covered type of horn.

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BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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Wapiti sparring with their antlers. The bull wapiti may indulge in playful sparring with a companion after the velvet has begun to leave the antlers. At the height of the mating season the sparring assumes a serious intent and the bulls exert their full strength against one another. On rare occasions the tines spring past one another and interlock so firmly that the animals can not free themselves. This means death for both animals either from predatory animals or from slow starvation.

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Horns and Antlers

Their Occurrence, Development and Function in the Mammalia[1]

H. E. ANTHONY

Curator, Department of Mammals of the World, American Museum of Natural History

Illustrations from photographs made in the Zoological Park unless otherwise noted

PART II

IT has been pointed out in the beginning of this article that antlers are bony in their nature as contrasted with true or hollow horns which are epidermal in their origin (with bony cores). Dr. Noback, in this issue of the BULLETIN, tells how antlers grow and describes the early stages of antler formation.

Antlers are the exclusive property of the deer, the Cervidae. Further than that, they are restricted (except in the case of the caribou) to the male deer. The males of all the living, typical deer (the Chinese water-deer is an exception) have antlers, but there are some deer, to be considered more or less aberrant (the musk-deer), which have no antlers on either sex.

Deer have always been featured in the chase as the favorite quarry of the hunter. In Europe the stag was royal game, in many countries reserved as the sole property of the king or of the nobility, and rather an extensive terminology has been built up about stalking and classifying the heads. A nomenclature was developed to classify the tines of the antlers, and the stag had various names to designate the degree of perfection attained by its antlers. A staggard is a stag of four years, not yet prime, a stag of ten has ten points, a royal stag has twelve or more points, et cetera. The term "antler"[2] was originally applied to the first branch of a deer's horn, but in time came to be applied to the whole deciduous structure.

Antlers are like trees in their faculty for adding branches each year. With the exception of the few deer that have unforked horns, the general scheme of growth is to add one branch each year until the bucks become prime adults, when the number of tines remains constant. When the buck has passed its prime the antlers gradually decrease in size and in other ways display a less vigorous and well-controlled growth.

Freak or abnormal antlers are not very uncommon and are sometimes to be attributed to internal disturbances, of which we can understand little, or may be due to the more obvious effects of emasculation through injury or advancing senility. Abnormalities usually take the direction of excessive branching and multiplicity of tines, and in extreme cases the

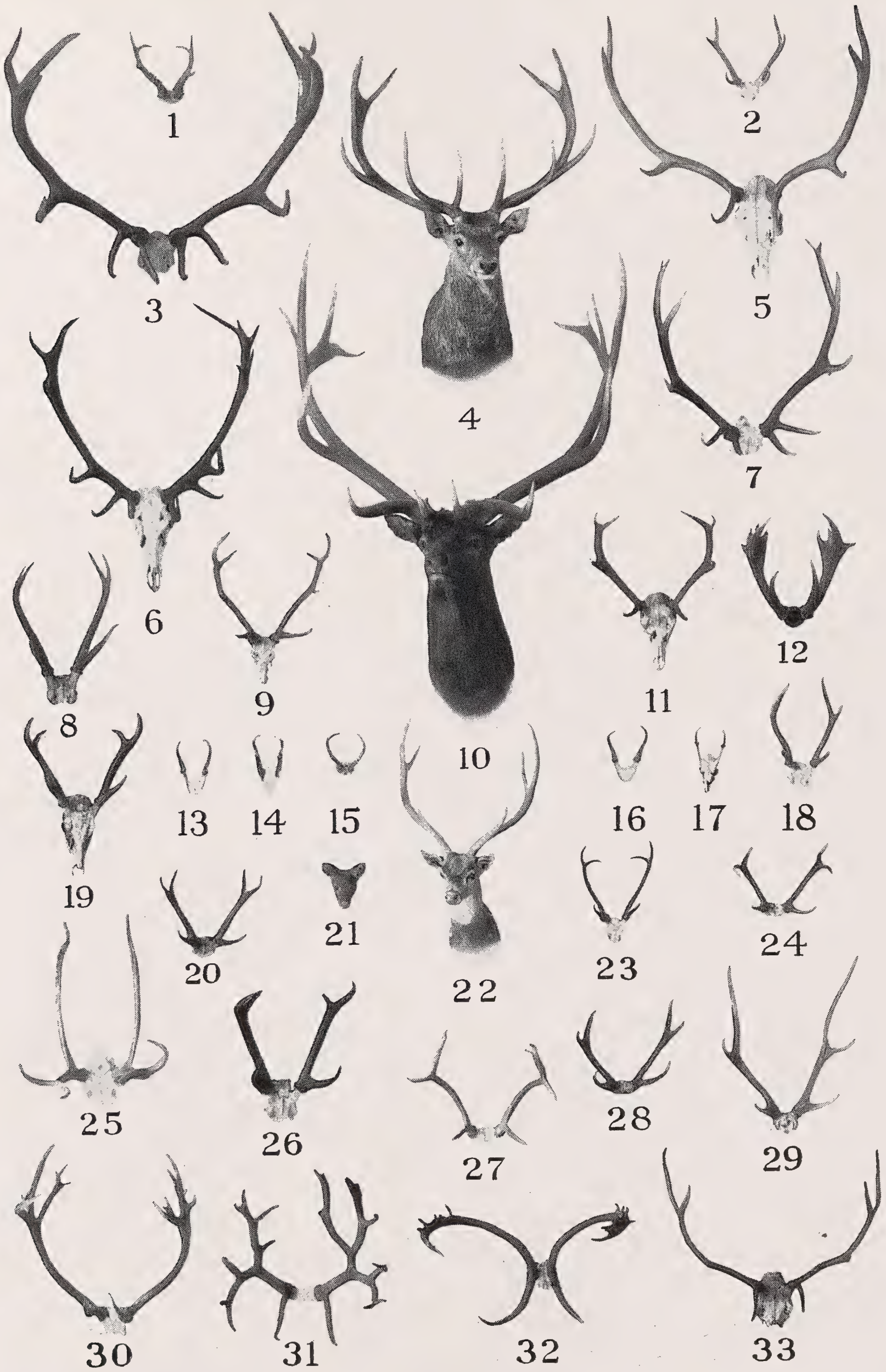
[1] The first part of this article, which discusses horns, appeared in the preceding number of the Bulletin.

[2] The derivation of "antler" goes back through the old French *antoillier* to a corruption of the Latin *antocularis,* before the eye.





Pleistocene deer of Europe and North America. (Above) Giant fallow deer or Irish elk of Europe. (Below) Deer-moose (*Cervalces*) of North America. Copyrighted. Restorations by Charles R. Knight, and published by permission of President Henry Fairfield Osborn, American Museum of Natural History.



Antlers of various types. 1. Siberian roe deer; 2. hog-deer; 3. Altai wapiti; 4. hangul; 5. Arizona wapiti; 6. Yarkand stag; 7. Manchurian wapiti; 8. Bornean sambar; 9. Japanese sika; 10. American wapiti; 11. Manchurian sika; 12. Malay sambar; 13, 14, 15, 16, 17. Various species of muntjac; 18. Basilan sambar; 19. Szechuan sambar; 20. Timor deer; 21. musk-deer; 22. axis deer or chital; 23. ketchang; 24. Luzon sambar; 25. Pere David's deer; 26. Indian sambar; 27. Pekin sika; 28. Formosan sambar; 29. Javan rusa; 30. barasingha or swamp deer; 31. Schomburgk's deer; 32. Eld's deer or thamin; 33. Thorold's deer. All figures to the same scale.



Different antler patterns; 1. Japanese sika; 2. Eld's deer or brow-antlered deer; 3. hog-deer; 4. Malay sambar; 5. roe deer; 6. wapiti; 7. Luzon sambar; 8. Schomburgk's deer; 9. Pere David's deer; 10. barasingha. All figures to the same scale.



Sketch to illustrate nomenclature of tines for red deer type of antler. 1. brow-tine or brow-antler; 2. bez-tine or bez-antler; 3. trez-tine, trez-antler or royal; 4. fourth branch and above form the crown or sur-royals. In the first year the buck develops merely a frontal protuberance, in the second year a simple spike, in the third year the brow-tine appears, and thereafter each year adds a tine until the maximum growth is attained.

typical pattern may be so obscured that the identity of the animal is difficult to ascertain from the antlers alone. Not infrequently the antlers of old bucks become stunted and otherwise retrogressive, and such heads, "going-back head," may differ noticeably from the normal pattern worn by the buck in his prime.

Mr. Madison Grant has noted the occurrence of an unusual type of antler carried by the white-tailed deer of the Adirondacks at the close of the last century. These bucks were known to the local guides and hunters as "swamp deer" or "meadow bucks" and carried antlers which were characterized by robust, heavy beam, extra points and tinelets, and rugose, papillate surface at the base. The "meadow buck" was recognized as something different from the other white-tails of the region and the antler difference appeared to be correlated with shorter legs, heavier body, dorsal stripe, and slight color differences on crown and antlers themselves. It is impossible to assert, with the data available, whether the peculiarities of the antlers of the "meadow buck"



Two characteristic American deer. The antlers of the white-tailed deer, above, are characterized by a pattern of simple tines on an unforked beam; the antlers of the black-tailed deer, below, (this is true of both mule deer and coast black-tailed deer) have the main branches of the beam forked to give off tines in pairs rather than singly. The right antler of this black-tailed deer illustrates an abnormal development and is a "freak" antler; the left antler is typical.



Malay sambar deer. The sambar deer include a number of subspecies that range from southern Asia down through Malaysia to the Philippine Islands. The sambar antlers are simple in pattern and are not very large and spreading, although robust and strong. The lower figure shows the male sambar, and the upper a female, one of the very rare cases of a female with antlers. This female was kept in the New York Zoological Park for a number of years and the antlers did not appear until the deer reached an advanced age.





(Above) The American wapiti, or so-called "elk" of American sportsmen, has superb antlers which at their best are beautifully symmetrical. (Below) The Kashmir stag or hangul (not as old an individual as the wapiti, above) carries antlers very like those of the American wapiti.



The caribou displays antlers intermediate in character between the round and the palmate type. The main beam of the antler is round, but the brow-tines, the bez-tines, and sometimes the crowns are palmate. The upper figure is the Osborn caribou, one of the group of mountain caribou, and the lower is the Grant caribou, a representative of the group of barren-ground caribou.





The fallow deer, above, has antlers with broadly palmate crowns which contrast noticeably with the round type of crown, such as that carried by the axis deer, below.



Among the most beautiful of all sets of antlers are those carried by the mountain caribou, typified by Osborn's caribou. The brow-tines are broad and heavy, the beam is expanded and the whole structure is developed along imposing and majestic lines.



Brow-antlered deer or Eld's deer. The beautiful antlers of this deer are noteworthy because of the extreme development of the brow-tine which appears to be a prolongation of the curving beam. The beam is set almost at right angles to the pedicle.



The antler of the muntjac or barking deer is set upon a greatly elongated pedicle which is densely clothed with hair. This pedicle is a conspicuous feature and is the cause of one of its vernacular names, "the rib-faced deer."

(a fine head killed by Mr. Grant and in his possession shows the apparent differences clearly) are, or were, heritable characters of real significance or merely variations within the range of possibility for normal white-tails. There seemed to be no heads intermediate between the "meadow buck" and the normal type, a rather suggestive state of affairs.

The range of individual variation for any given species of deer may permit of considerable antler modification. The abundance or scarcity of food has some effect upon the growth of antlers which, in the case of species like the moose, undoubtedly is a heavy drain upon the vitality of the animal. The surface of the hardened antler is colored, to some extent, by the objects against which the deer rubs to strip off the velvet.

The characters of antlers are sufficiently definitive to form a useful basis for a classification of the deer. While individual variation within a species may be considerable, the fundamental pattern of the antlers remains within limits sufficiently narrow to mark off one group from another. Antlers reproduce themselves on a given individual with remarkable consistency, and any little deviation from the normal that appears will probably reappear as an annual feature.

Deer have been grouped accordingly as the antlers have conformed to certain definite patterns. For example, the elaphine group (containing the European red deer and the wapiti, among others) is characterized by rounded, complex antlers which usually carry a bez and always a trez-tine, and the damine group (containing the fallow deer) is distinguished by antlers which normally lack the bez-tine and are more or less palmate above the trez. In the group of American deer the various subspecies of the Virginia deer have antlers the tines of which arise from a nearly horizontal beam and are upright, unforked spikes; the subspecies of mule deer and black-tailed deer carry antlers, the main branches of which fork dichotomously and present an appearance very distinct from the Virginia deer type. The extreme example of dichotomous forking is shown by Schomburgk's



The great moose of the Kenai peninsula, Alaska (*Alces gigas*), grows a massive pair of antlers that constitute the heaviest horns to be found on living mammals. When one realizes that this extensive structure is an annual growth and is dropped shortly after it has hardened and reached a useful stage, wonder is aroused at the wastefulness of the process. The yearly growth of such antlers as these must be a very heavy drain upon the vitality of the animal.

deer where the main branches fork again and again.

The simplest antler is the straight spike of the brocket deer. This is similar in form to the first-year antler of many other deer[3] but in the brockets the antlers remain simple and never branch. The brocket antler does not attain a very great length and seldom exceeds five or six inches. Between this simple type of antler and the complex, many-branched antler of Schomburgk's deer or the palmated, many-tined antler of the moose, there is a vast difference, but there are many intermediate

[3] The name brocket was first used for the young red deer stags and properly belongs to them, but has now become widely used for the small deer of Central and South America.



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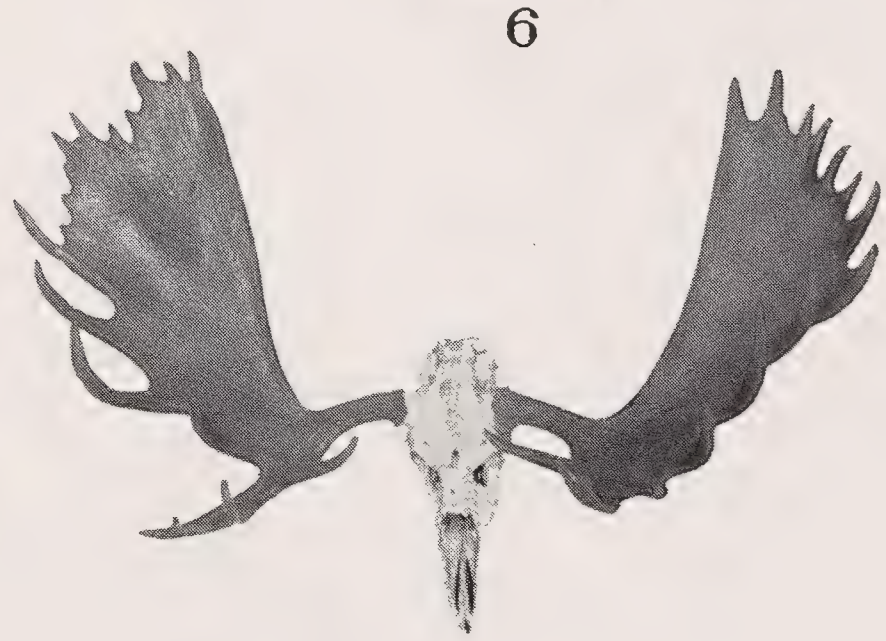
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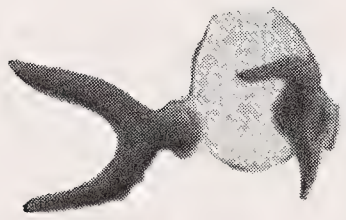
Types of moose antlers. 1. Shiras' moose (Wyoming); 2, 3, 5, 8. Alaskan moose; 4. Canadian moose; 6. Siberian moose; 7. Scandinavian moose.
All figures to the same scale



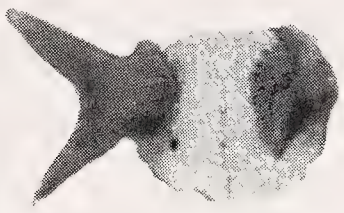
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Antlers of South American deer. 1, 2. Colombian white-tailed deer; 3, 4. guemal; 5, 8. marsh deer; 6. Brazilian white-tailed deer; 7. pampas deer.
All figures to the same scale

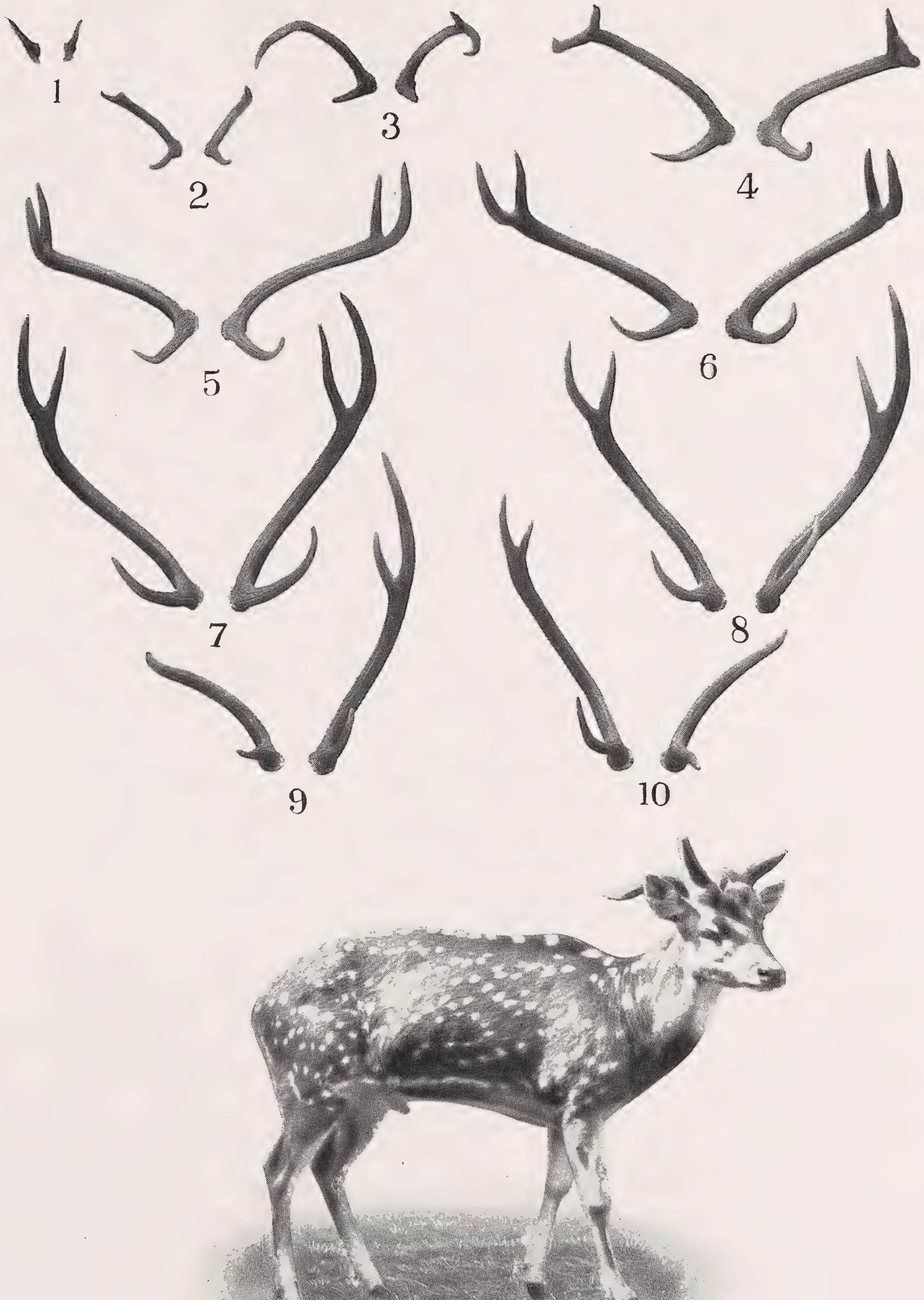
types of antler which bridge over the gap, and the transition is not abrupt. The illustrations will serve to call attention to the various types and patterns of antlers better than written descriptions.

Antlers came into the fossil records about in Miocene times. *Merycodus,* of the North American middle Miocene, had deer-like, branched antlers which may not always have been deciduous. The condition of the burs on some of the specimens indicate that the antlers may have been permanent. Prior to the Miocene the ancestral deer appear to have been hornless. Some writers believe that the deer antler was evolved from a giraffe-like horn, a bony process on the skull covered by undifferentiated skin. This skin was subject to injury, being soft and containing nerves and blood vessels. In due course of time the horn developed a bur or basal ring and the blood supply to the soft skin covering of the upper horn was cut off. When this skin died and stript off, the bony antler as it is known today was the result.

The function of antlers seems to be rather clearly that of a highly specialized sex character. With the exception of the caribou, antlers are carried only by males and become functional and of service to the animal for a limited time, namely, during the breeding season. For most of the year the male deer is either without antlers or the antlers are in the velvet and of no use as weapons. As a defensive mechanism for the group, antlers, therefore, have but little value. Even when carrying fully developed and hardened antlers, deer more often than not flee before attempting to employ these weapons against any formidable enemy. The males of most deer make more or less use of their antlers against one another during the rut, but even against their own kind it may be questioned whether antlers are necessary weapons. It has been noted in deer parks that the master bucks are sometimes possessed of but small antlers or may even be hornless. Antlers are not necessarily the *sine qua non* of domination.

In the one genus (the caribous) where antlers are not obviously a sex-linked character, the antler of the female is conspicuously smaller than that of the male, but is carried for a longer period of time, not being shed until well on in the spring when the calf is born. It has been stated that the possession of horns is an advantage in the dead of winter when the animal must scrape snow away from the vegetation that is its food, and that the larger, hornless males are apt to go hungry at such a time. In this fact may lie the explanation for the horns of the female caribou, they are useful structures, originating and connected with the sexual cycle, but carried over through a period when the unborn young are threatened with a lack of nourishment. No species of hornless (females) deer range as far north as the caribou and we have no way of telling, except by inference, how hornless females would survive the rigors of a winter on the barren grounds. There may be no especial significance attached to the fact that female caribou are horned, but it is strange that no other female members of the widely spread and numerous family are so endowed and rather tempts one to speculate. It is significant to note that the male deer which do not carry antlers—water-deer and musk-deer—have developed the canine teeth into large keen tusks. The females of these species do not have the tusks which are, like antlers, to be considered as sex characters.

Antlers have figured rather extensively as artifacts of early man. The substance of antlers could be easily worked by him and yet was strong and substantial enough to serve a variety of uses. Fragments of antler served as handles to hold flint implements; the beam of an antler might be used with sinew to form a compound bow; or the head of a spear might be formed of the dense tip of an antler. As later uses of antlers might be mentioned the gun-racks of Europe and North America, the sword-racks of Japan, and the almost universal employment of stag-horn for small objects such as knife handles. The demand for stag-horn for handles has been great enough to develop an extensive use of bone, processed to imitate antler, as a substitute. Antlers were an early source of ammonia, and spirits of hartshorn takes its name from the fact that the distillation of antler shavings was formerly used to provide this ammoniacal preparation.



Series of antlers from the same individual. The antlers from an axis deer, in the New York Zoological Park, were saved each year to form an interesting series. It will be noted that there is a regular annual increase in size from the first set to the seventh, when the antlers have attained their peak. In the seventh and eighth sets the antlers hold at maximum size and then lose in the ninth and tenth seasons. The deer is figured with its final set of antlers which are distinctly stunted and degenerate.
Fig. 1—10 all the same scale



Asymmetrical antlers: Bucks past their prime may grow antlers that are not symmetrical, one side may be longer or of a pattern differing from the other. Injury to the growing horn may also cause asymmetry.



Unusual types of antlers. The antlers of the mule deer, above, are abnormal and belong to the class of "freak" antlers. Some disturbance in the internal control of the antler-growing mechanism has allowed a wide departure from the normal mule deer pattern. The antlers of Schomburgk's deer, below, are not "freak" growths but of the type habitually developed by this rare species.



Interlocked antlers of Alaskan moose (above) and mule deer (below). The many-branched type of antler sometimes brings its wearer into difficulties and dangers unknown to the wearer of hollow horns. Fighting male deer may lock antlers so tightly that they can not be extricated, and this occurs oftenest among the species that carry antlers with many tines or branches. Antlers possess a notable degree of springiness and because of the configuration of certain patterns these may be sprung into a locked condition which will require more than the original energy to withdraw them. Also the impact which interlocks the antlers may gain energy from the unhampered freedom of the thrust, a momentum which the animals can not secure once they are entangled head to head.





Intermediate stages in the growth of antlers. The soft covering of downy skin on the growing antler is known as "velvet" and is, in a sense, comparable to the tender bark on a growing twig. Under the "velvet" the blood is building up the bony tissue of the antler and each tine or branch follows the pattern set by the rapidly advancing "velvet." While the antlers are in the "velvet" the bucks are not aggressive and frequently associate in small bands. Not only do they feel none of the rivalry that will come later when the antlers are complete, but any use of the soft antlers at this stage of their development would result in considerable pain.

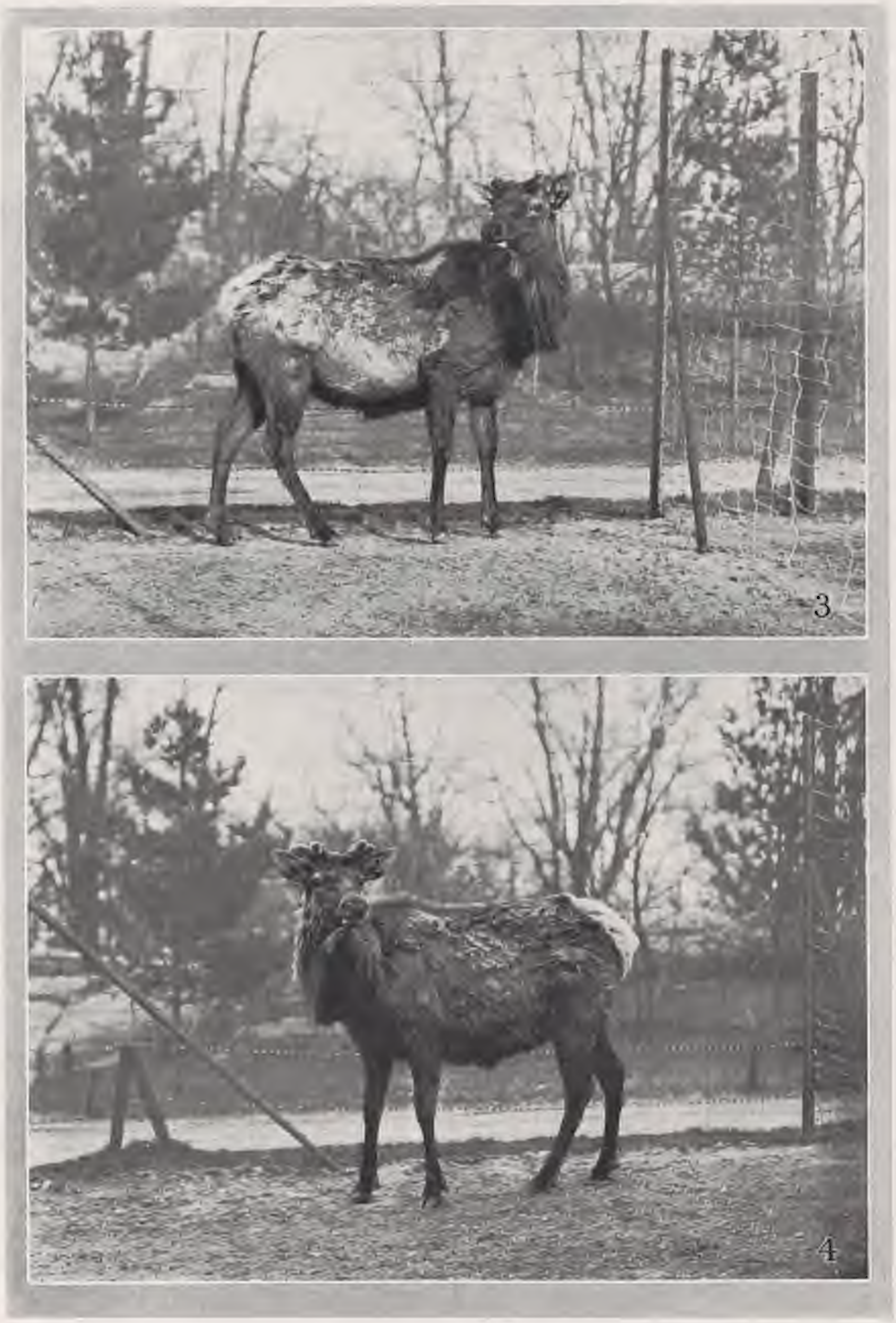
The Growth of a Wapiti Antler

THE following series of photographs illustrates progressive stages in the development of the wapiti antler and, with the exception of Numbers 9, 15, and 16, all of the photographs show the same individual. The animal was observed daily and a photographic record made which extends over a period of several months. It should be noted that these pictures are an equally good record of the shedding of the winter pelage and the acquiring of the new coat. The series closes with two photographs, Numbers 15 and 16, selected to emphasize the change in demeanor of the wapiti when his antlers have become prime. Both of the latter pictures are records of the same animal. Photographed by Elwin R. Sanborn at the New York Zoological Park.

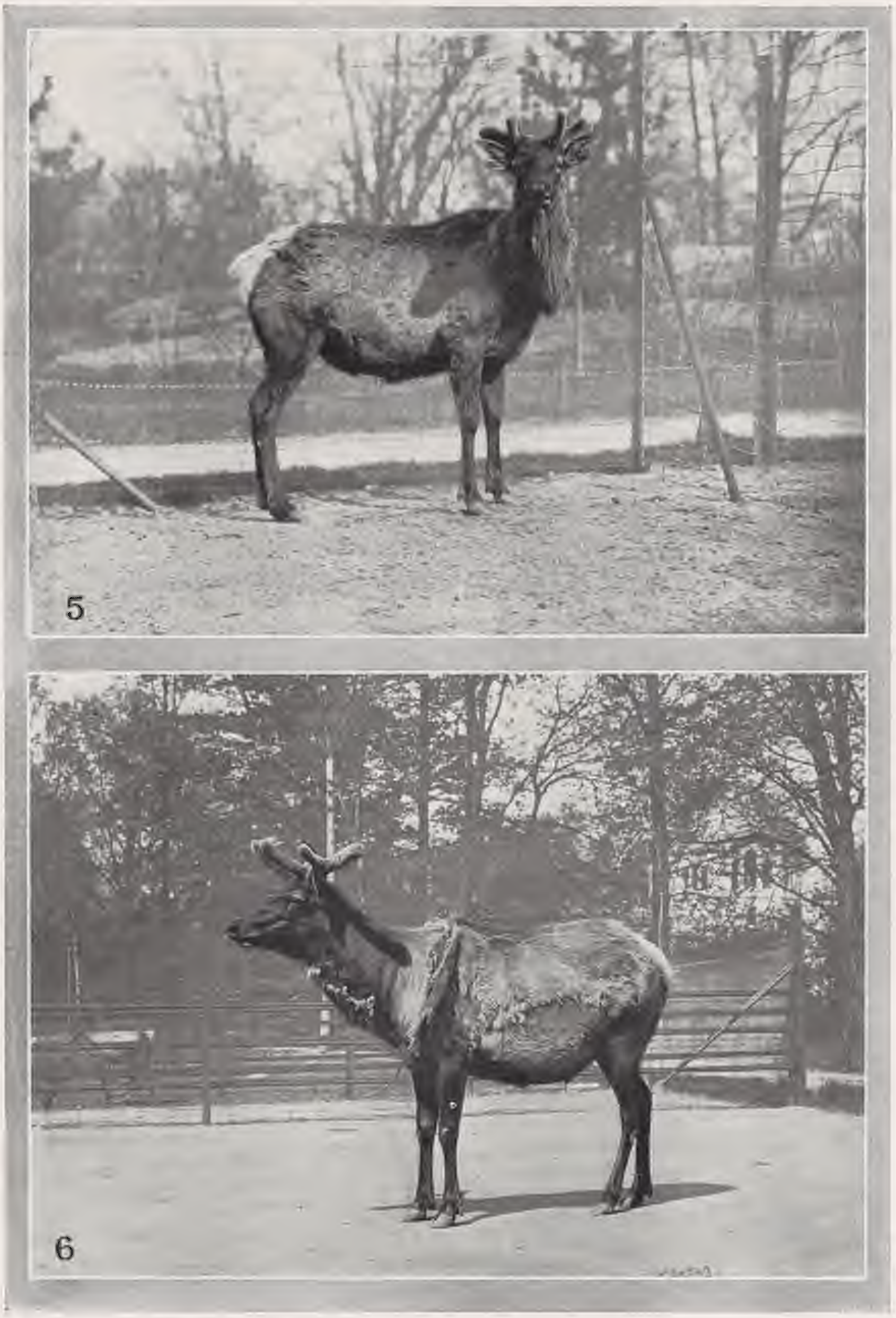




1. The wapiti has begun to shed the old antlers (March). One has already dropped and the exposed surface of the pedicle is readily apparent. The long winter coat begins to look rough. 2. Both antlers have fallen. At the proper time any slight jar or quick movement is sufficient to break the weakened attachment to the pedicle.



3. The new antler appears as a tumid bud on the pedicle (April 29); the winter coat has started to go. 4. The branches which will grow into brow-tines and bez-tines appear early (April 25).



5

6

5. Every day sees an increase in the side of the antlers (May 5). 6. The branching begins to foretell the pattern of the final growth (May 9) and the last of the old hair is ready to shed.



7. The wapiti needs plenty of green vegetation to meet the demands for antler growth, and by the time this structure is assuming breadth and height (May 16), plant life is well in foliage. 8. The antlers are now (June 1) the dominating feature of the animal's appearance; the new coat is established.

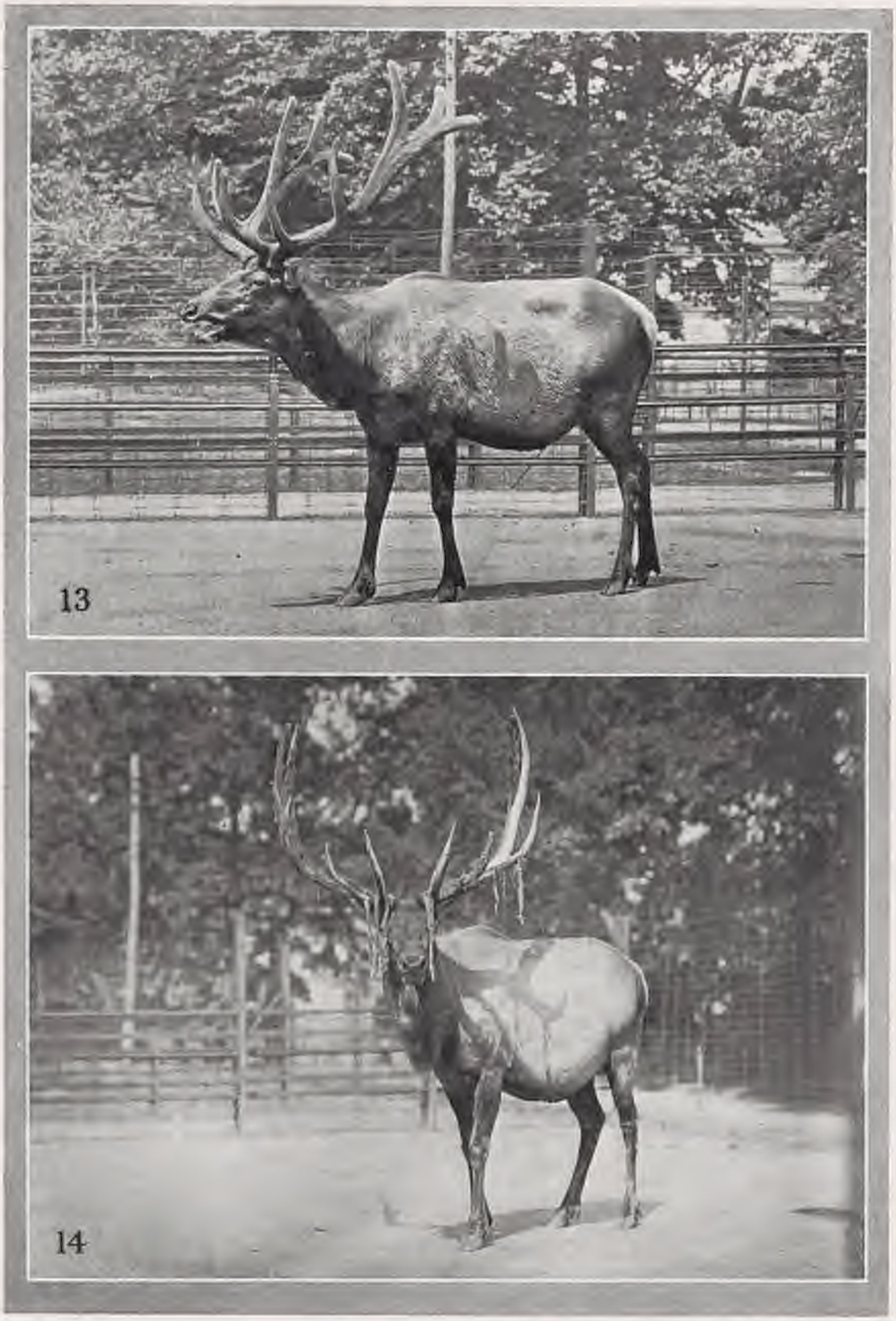




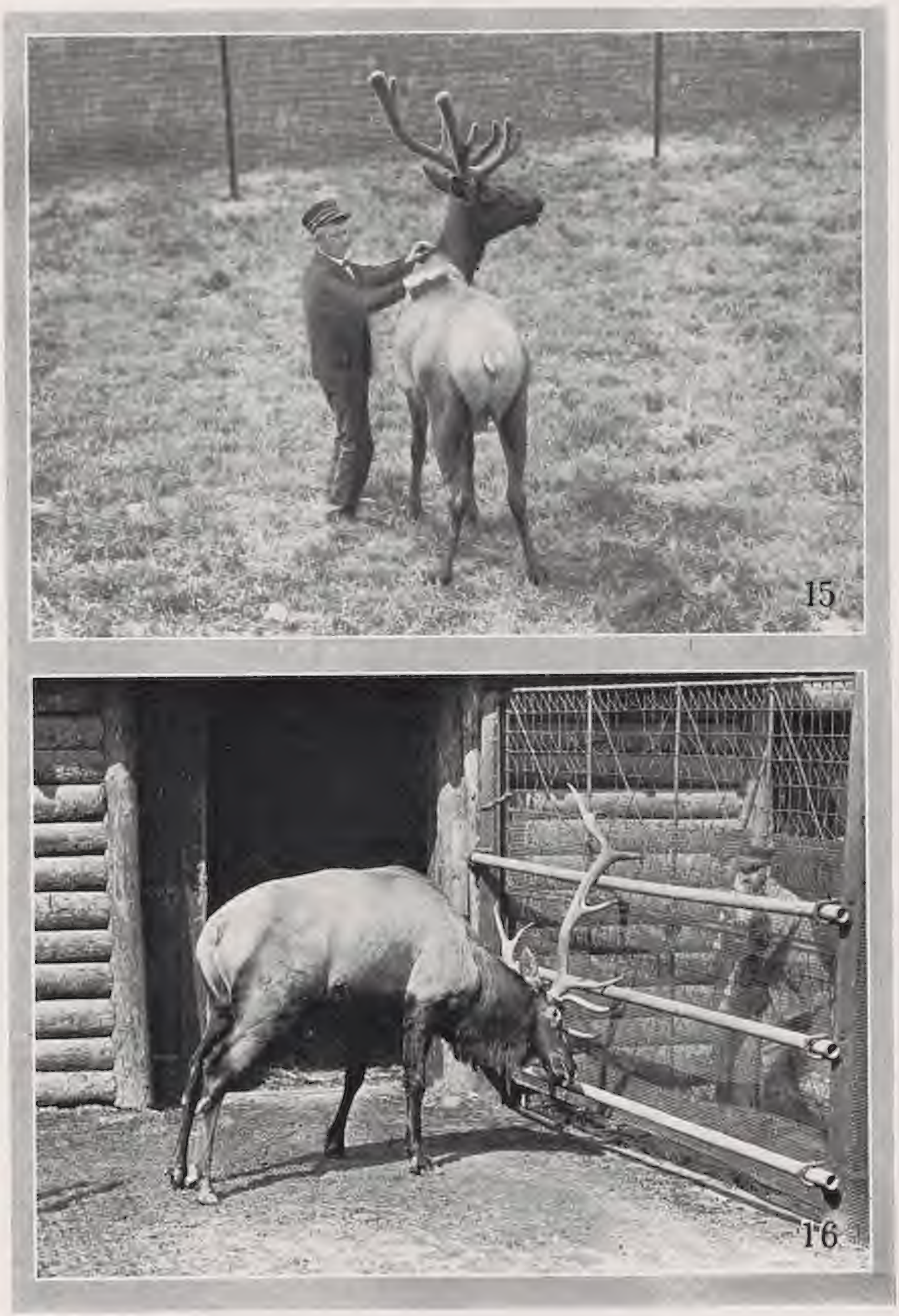
9. As the antlers become larger the wapiti will be forced to exercise greater care to avoid striking them against hard objects, for the velvet is still soft and filled with blood vessels. If injured it will bleed and an injury may deform the antler. Number 9 is not the same individual as the rest of the series; it is included to give a better idea of the antler in velvet. 10. The thick covering of velvet on the tips of the growing antlers makes the antlers look clumsy and club-like and masks the trim structure which will later make its appearance (June 25).



11. The antlers are entering into the final stages of size-development (July 6) and all of the branches and tines have been outlined. 12. The general condition of the wapiti has been improving as the season advances, and with the antlers assuming nearly their full extent (July 12) the animal's body is becoming sleeker and more rounded.



13. After the full pattern has been completed (August) the growth processes will be devoted to the hardening of the antler. (The wapiti feels the heat of midday). 14. The antlers are hard and serviceable (August) and the velvet has served its function. It is now dead tissue and can be stripped off in shreds. The wapiti rids the antlers of the useless velvet by rubbing them against brush and saplings. Note the plump, vigorous body.



15 and 16. These photographs show the same individual at different seasons. When the antlers are in the velvet (15) the park wapiti is docile and displays no eagerness to use its antlers. After the velvet has been stripped (16) the animal is decidedly untrustworthy and charges violently against the barrier in the attempt to reach the keeper.

The Internal Structure and Seasonal Growth-Changes of Deer Antlers

CHARLES V. NOBACK
New York Zoological Park

Illustrations from photographs made in the Zoological Park by Elwin R. Sanborn

THE following description of the internal structure and growth of the deer antler is based upon a study of three antlers from the Virginia deer (*Odocoileus virginianus*), and the head of a Columbia Black-tailed deer (*Odocoileus columbianus*). These specimens were obtained at the New York Zoological Park during the past year. The first, an antler in early velvet, representing about two months' growth, was obtained on June 1, 1928, as the result of its having been broken off accidently above the pedicle. The second antler, representing a growth of about four months, came from a buck which died on July 25, 1928. The third, representing about six months' growth, was secured on October 4, 1928. The head of the Columbia Black-tailed deer came from an old buck which died on January 28, 1929, four weeks after shedding its antlers.

These specimens were sectioned longitudinally while in a fresh state, photographed and preserved in Kaiserling's solution. The photographs accompanying this article will illustrate the internal structure of the antler at various stages of its seasonal growth.

A tough elastic substance known as keratin (from Greek keras—horn) is the essential constituent found in the outer layer of the skin covering the mammalian body. Keratin, which is insoluble in water and in very weak alkaline or acid solutions such as are found in nature, belongs to a class of chemical substance known as scleroproteins or hard proteins, and is composed of carbon, hydrogen, oxygen, nitrogen and sulphur. The odor of burning hair, horn, or hoof when horses are being shod, is characteristic of keratin. A similar substance, chitin (Greek chiton—tunic) coats the surface of higher invertebrates, such as crayfish, centipedes, insects and spiders.

The importance of keratin may be realized when we recall that it is the most important constituent of the corneum, which protects the delicate and sensitive structure of true skin from the effects of mechanical and chemical irritation, moisture, heat and cold. In this way nature uses keratin to protect the surface of the animal body. Those portions of the body exposed to friction and irritation are protected by a compensatory thickening of the epidermis together with a corresponding increase in its keratin content, as for example, the callosities on exposed parts of the body, the claws of dogs and cats, the nails of ape and man, the horn on the nose of the rhinoceros (rhino—nose; ceros—horn), and also the horns of cattle, sheep, goats and antelopes. The thin keratin layer of the skin functions somewhat as a coat of armor by protecting the body against invasion by ever-present invisible microorganisms, which are frequently more fatal than physical injuries themselves. As long as the keratin surface, or the corneum, is intact infection through the epidermis cannot occur.

Externally, there is a marked difference between horns and antlers. The hollow horn, or keratin sheath, in the Bovidae extends from the skin as an outgrowth of the epidermis and is reinforced by an osseous core growing out from the frontal bone. True horns are relatively permanent structures, continuing throughout the life of the animal, being gradually renewed as they wear out, similar to the renewal of hoofs, claws or nails. The horns of the prong-horned antelope, however, are shed annually.

With rare exceptions, all male deer (Cervidae) possess antlers which are deciduous, osseous growths springing from the pedicle of the frontal bone and are not encased in a keratogenous or horn sheath. None of the female deer possess antlers with the exception of the antler-bearing female reindeer (*Rangifer tarandus*).

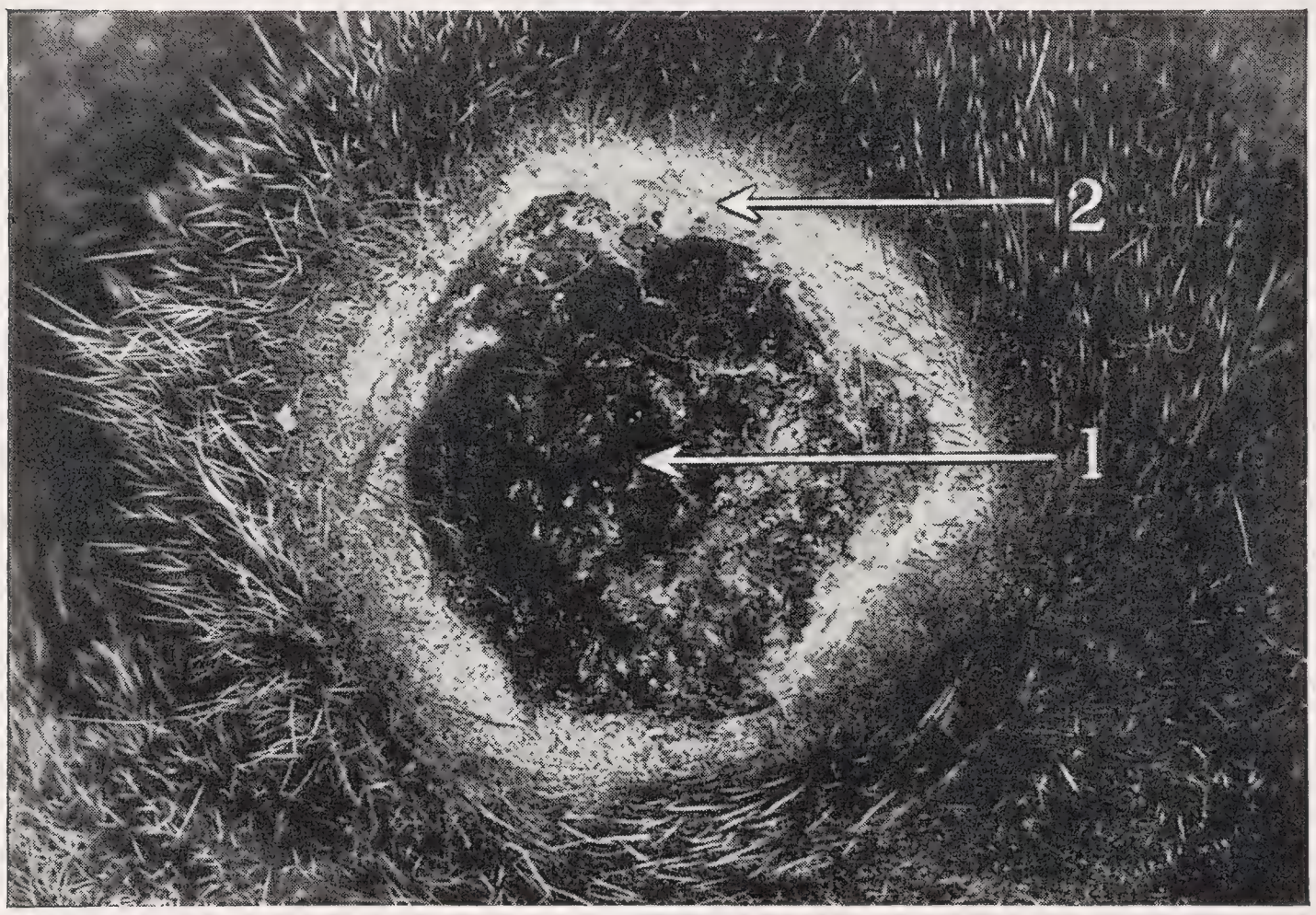


Figure 1

Tip of pedicle two weeks after the antler had been shed. 1. A thin layer of dried blood covering the pedicle tip. New connective tissue embryonic in character is forming just beneath the scab. This tissue is the beginning of a new antler. 2. Edge of the pedicle skin surrounding the denuded tip. The velvet, a form of skin, will evolve from this border and grow to completely cover and protect the delicate tip of a new antler.

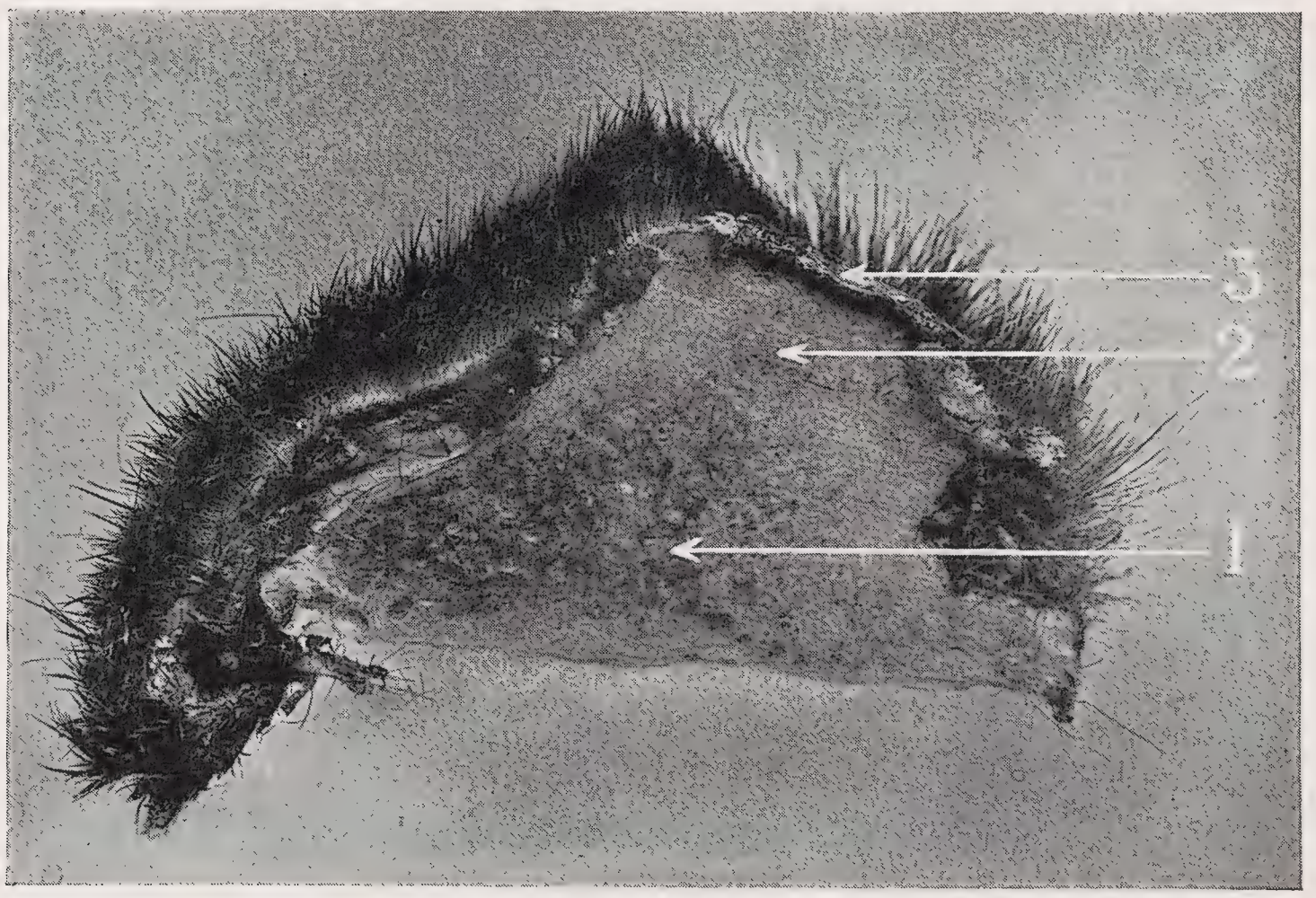


Figure 2

A longitudinal section of the pedicle shown in fig. 1. 1. Frontal bone, from which the new antler will derive its blood supply. 2. The pedicle, a cylindrical growth of bone from and a part of the frontal bone. It is from the tip of the pedicle that the new antler will grow. 3. A layer of dried blood covering the tip of the pedicle two weeks after the antler was shed. The velvet will evolve from the edge of the skin surrounding the pedicle tip.

The term horn, in its narrowest sense as used here, refers to the keratogenous sheath as it occurs in cattle and antelope, consequently it may be said that true horns are not present in deer.

In this latitude, during late winter or early spring of each year, the mature antler is shed, after which a new one grows from the tip of the pedicle. The exposed surface of the osseous pedicle (figures 1 and 2) is bare at the time of shedding. The marginal border of skin is the source of a cutaneous structure, the velvet, which soon envelops the free surface. While the velvet is developing a profound change is taking place within the tip of the pedicle, for simultaneously with an increase in the blood supply to this part, a mass of young connective tissue, embryonic in character (Macewen[1]) is beginning to form. This connective tissue becomes cartilaginous in character and is later replaced by bone. Bone formation takes place through the development of bone-producing cells (osteoblasts) within the cartilage together with the deposition of calcium and phosphate salts.

The growth of modified skin, the velvet, which later becomes covered with fine short hair, protects the cartilaginous cap and gives the tip of the pedicle an external appearance resembling a large brown mushroom. The velvet is highly vascular and sensitive, since it is richly supplied with blood vessels and sensory nerves extending to it from the adjacent skin.

It may be mentioned that the pedicle is a cylindrical outgrowth from and a part of the frontal bone of the skull. The relation of the frontal bone to the pedicle is shown in figures 6 and 7. The blood supply of the pedicle is derived from the internal vascular system of the frontal bone.

Growth of the antler seems to take place somewhat as follows: The cap of tissue resembling cartilage with its tip of young connective tissue "grows out" while the tissue at the base ossifies in being replaced by bone tissue. Bone formation is more intense within the wall of the antler so that on examination we find that the bone in the wall of the cylindrical antler shaft is very compact in comparison with that of the interior. The interior of the antler is filled with a mass of soft bone tissue, a veritable network of very fine tubes, which serve to supply the growing tip with an adequate amount of blood from the Haversian systems of the pedicle and frontal bone. The growing tip is dependent for its nourishment upon the blood received from the frontal bone through the pedicle.

With the formation of bone at its base the antler "sets" and does not materially increase in width. Growth continues until the predetermined antler pattern has been completed, by which time the cartilage-like cap ceases to grow and calcification continues until the mature antler consists of a mass of compact bone. While the following analogy is not exact, one might think of the growing antler as carrying on a process of growth similar to growth of the soft, delicate polyps on a coral tip. Just as the wall at the base of the antler hardens and "sets" as compact bone, so in a similar manner the mass of polyps on the tip of coral die and calcify to form coral. Both of these processes are forms of calcification. In the case of the antler, growth takes place by a deposition of calcium obtained from within the animal body through the blood stream while in the case of coral the growth is one of accretion where the calcium is obtained from without.

The gross internal structure of a young growing antler is illustrated in the accompanying photograph (figure 3) of a longitudinal section through a two months' growth of antler in velvet. The photographed specimen was secured on June 1 as the result of having been broken off accidentally. All the stages of growth in a growing antler may be seen in this photograph. A good view of the velvet and its hair may be seen in figure 4, the photograph of a cross section from the beam of the antler where numerous blood vessels in the velvet are plainly visible. The gross structure of the growing shaft is seen to consist of spongy bone richly supplied with blood, while the wall consists of more compact bone where calcification is more complete. At the tip one can clearly see how the growing bone sends fine, delicate processes into the cartilagious tissue above in such a manner as to leave no clear cut line of demarcation. The growing bone imperceptibly merges in with the cartilaginous tissue

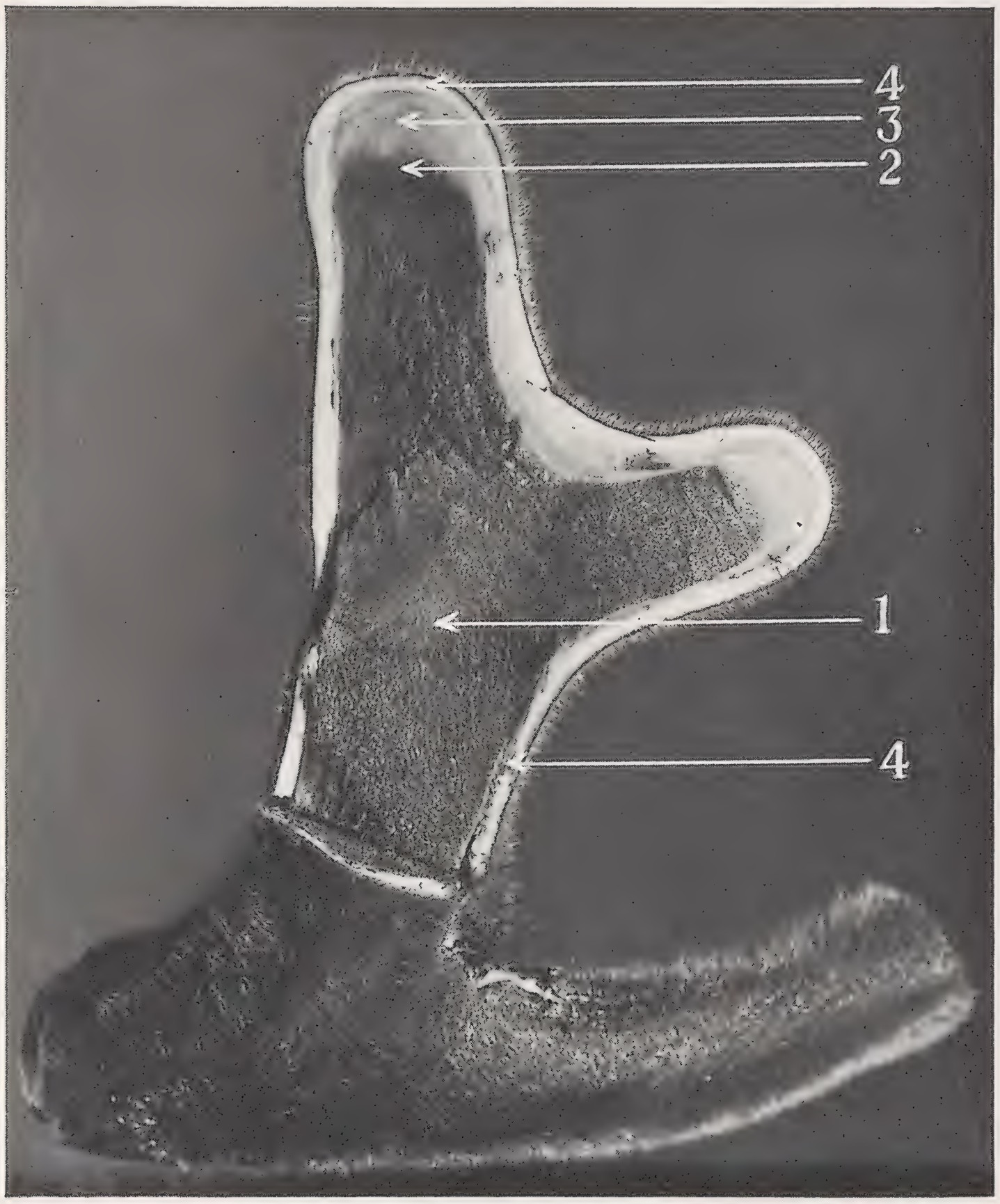


Figure 3

Longitudinal section of a two months old antler. The gross internal structure of a young growing antler is illustrated above. 1. Young newly formed bone, spongy and richly supplied with blood. 2. Area in which fine delicate processes from the tip of growing bone extend into the cartilaginous young connective tissue cap, which forms the tip of the budding antler. It is in this region (2 & 3) that the active process of growth and elongation takes place. 4. The comparatively thick white border enveloping the antler is the velvet. The thin dark border of the velvet is the pigmented layer just beneath the hair.

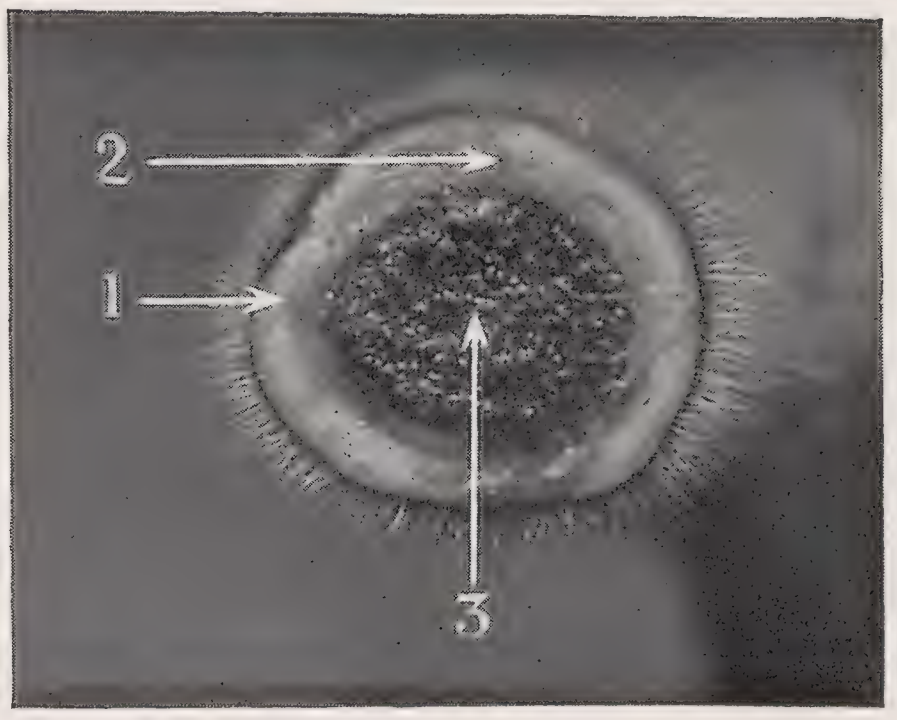


Figure 4

Cross section of a young antler. Cross section view of the two months old antler shown in figure 3. 1. The velvet, a thick cutaneous structure enveloping the spongy bone, 3, of the growing antler. The hair of the velvet is plainly visible. The abundance of short hair gives this structure an external velvety appearance, hence its name "the velvet." 2. Bloodvessel within the "velvet."

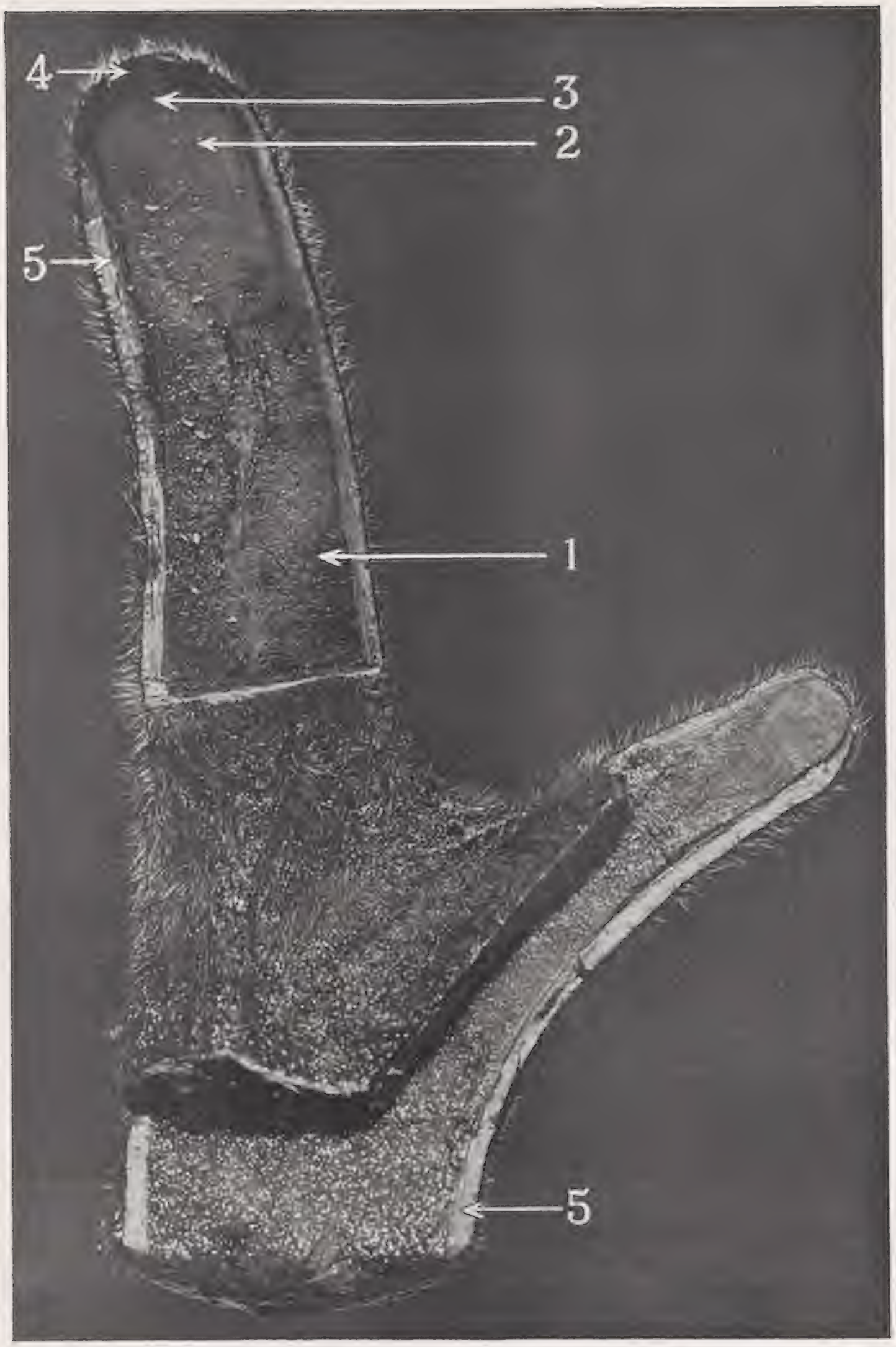


Figure 5

Longitudinal section of a four months old antler. The cartilaginous tip at this stage is practically replaced by young bone and the antler pattern has apparently been achieved. 1. The bony body of the antler is more compact at this stage indicating that its growth is being completed. 2. Hardening and ossification of the cartilaginous tip appears to have been completed. 3. Last trace of the disappearing cartilaginous connective tissue destined to be replaced by bone. 4. Velvet of the tip is dark, shriveled and dead. This is a point at which shedding of the velvet begins. 5. Living velvet still preserved below the tip.

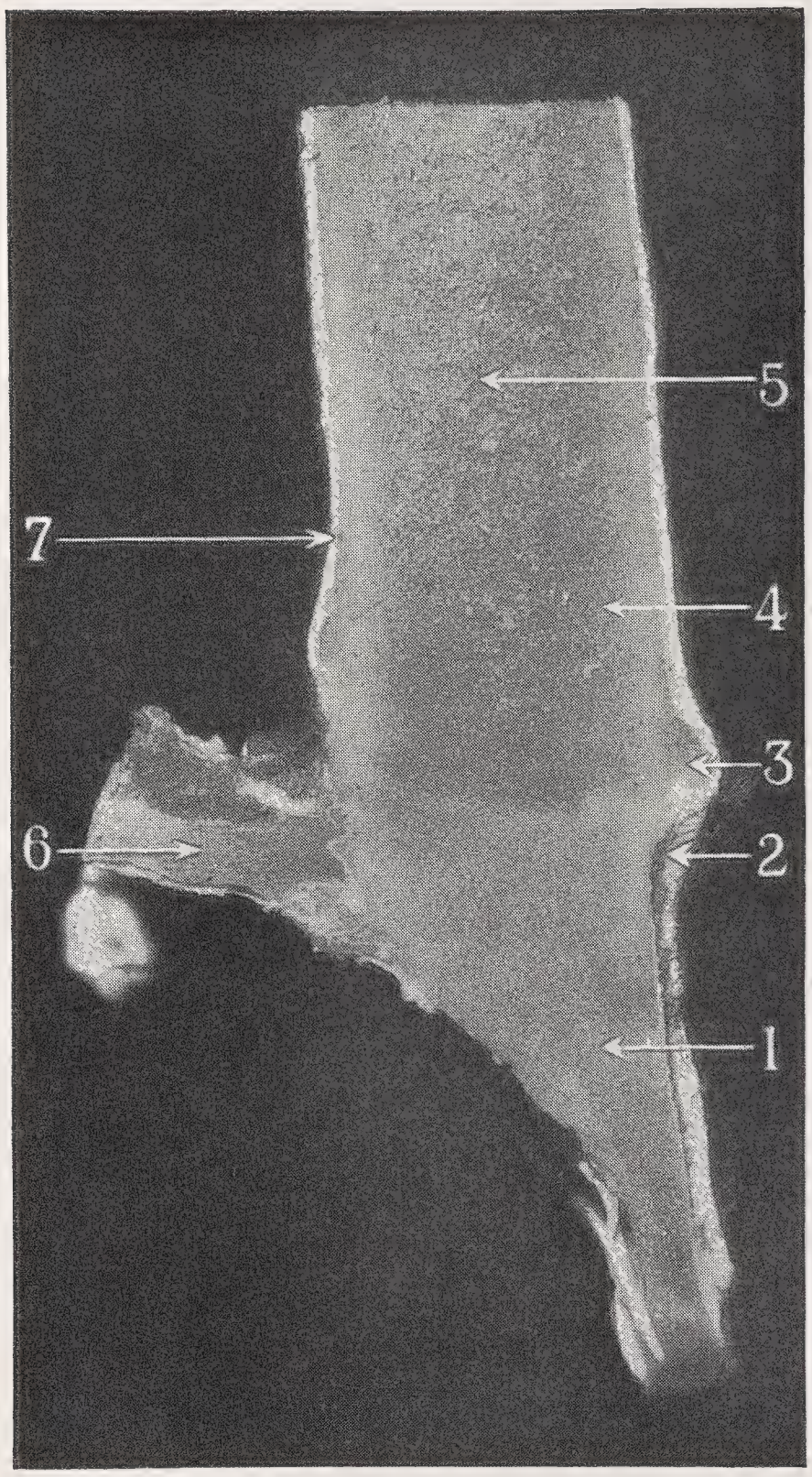


Figure 6
Longitudinal section through velvet antler, pedicle and frontal bone. (Four months antler). 1. Frontal bone with pedicle just above. 2. Skin covering the frontal bone. 3. The burr or corona at the base of the antler, an over growth of the base of the antler. 4. Wall of antler more compact than the interior. 5. More spongy interior of antler. 6. Part of parietal bone of the skull. 7. velvet.

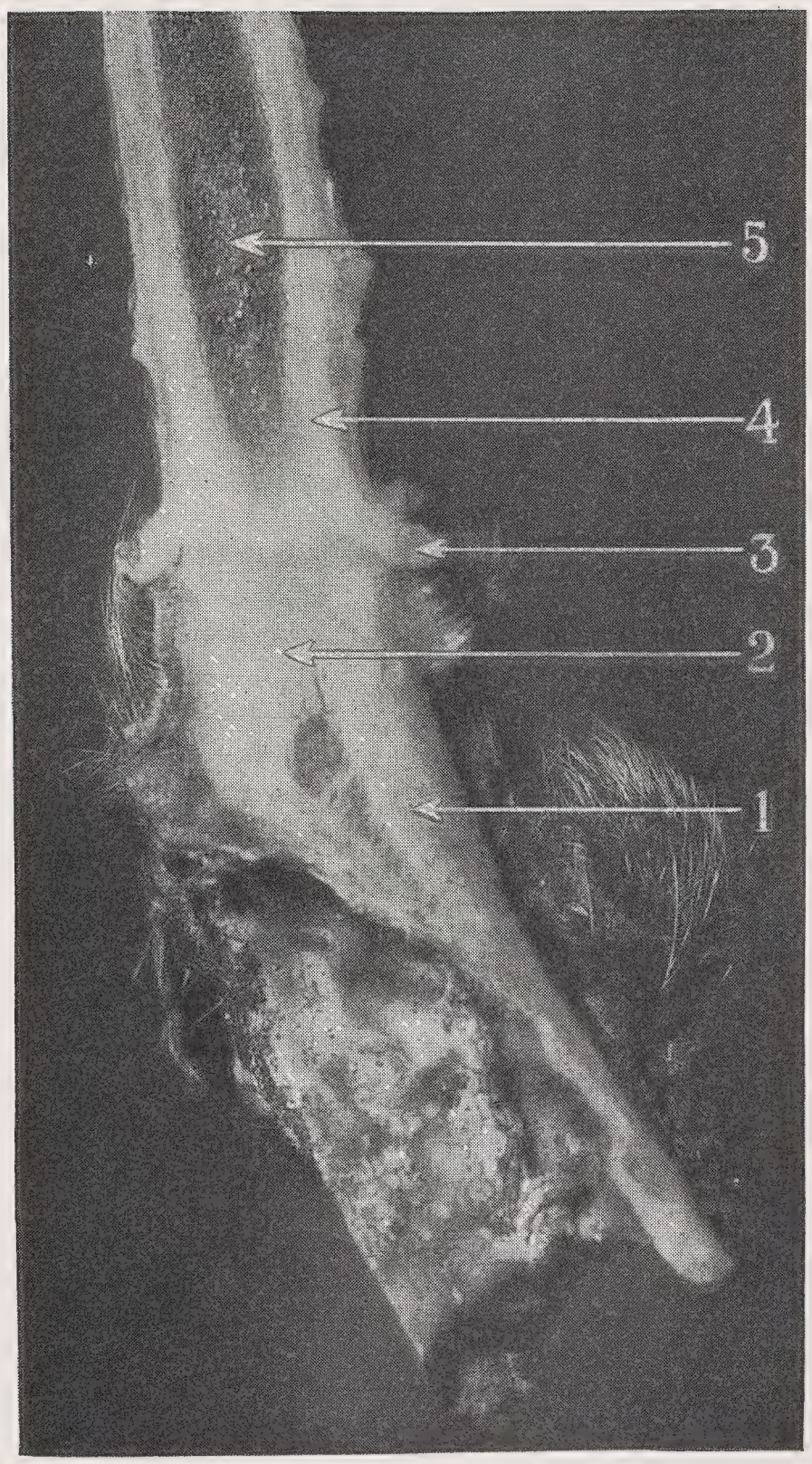


Figure 7
Longitudinal section of a mature antler. (Six months old). 1. Frontal bone with its center of ossification. 2. pedicle. 3. Burr or corona. 4. Compact bone wall and base of the mature antler. No velvet is present. The light area of the base of the antler stands out in contrast with the bone of the pedicle. It is along this line of demarcation that the separation of antler takes place when it is shed. 5. Spongy character of the interior of the antler.

Photographs by E. R. Osterndorff

so that these tissues dovetail one into the other. This juncture is the area in which the active process of longitudinal growth is taking place. It is here in this vital area that numerous primitive bone cells, called osteoblasts, are found which on calcifying replace the cartilaginous tissue and form the bony antler. This bone formation apparently serves as the base of new operations to continue the outward growth of the antler until its predetermined pattern has been completed.

Externally, enveloping and protecting the delicate mass of growing tissue we find the velvet, an outgrowth from the skin of the pedicle containing all the elements of true skin. The velvet is richly supplied with blood vessels, sensory nerves, glands and hair, and as it is very sensitive, causes the animal to avoid contact with hard objects. While in velvet, the antler may possibly be thought of as possessing a keratin coat because as the velvet is true skin, it possesses an external layer of keratin to protect it against abrasion and the entrance of microorganisms.

A later stage illustrating the internal structure of a four-months-old antler is shown in figure 5. It will be seen that the clear cartilaginous tip has been practically replaced by young bone. A few traces of cartilaginous tissue are still present. The antler as a whole is becoming more compact as bone formation is being completed. Cessation of new cartilage formation and calcification of the tip indicate that the antler pattern has been achieved.

Another point of interest to note is that the velvet covering the tip of the antler has begun to degenerate, as indicated by its darkening and drying out. Below the tip, the velvet is still living and contains some blood, but the velvet covering the tip is dark, shriveled and dead. It seems that one of the areas where the shedding of the velvet may begin is at the tip of the matured antler.

Figure 6, illustrating a longitudinal section through the velvet, antler, pedicle and frontal bone, will serve to show the relationship of these four structures. It can be seen that at this stage the antler bone is less compact than the frontal bone. The line of demarcation between antler and pedicle is clear.

Figure 7 shows the internal structure of the mature antler, pedicle and frontal bone obtained by a longitudinal section. It will be noted that the antler is bare, free of velvet, and is composed solely of bone. The wall of the mature antler is seen to consist of hard compact bone while the interior still contains spongy, vascularized bone. The base of the antler is seen to consist of firm compact bone, with a ring of bone overflowing the base to form the corona or burr. The line of demarcation between antler and pedicle is clear and distinct. It is along this line that separation of the antler takes place when the antler is shed and it is from this region of the pedicle that a new antler develops. Complete ossification of a mature antler tip is seen in figure 8.

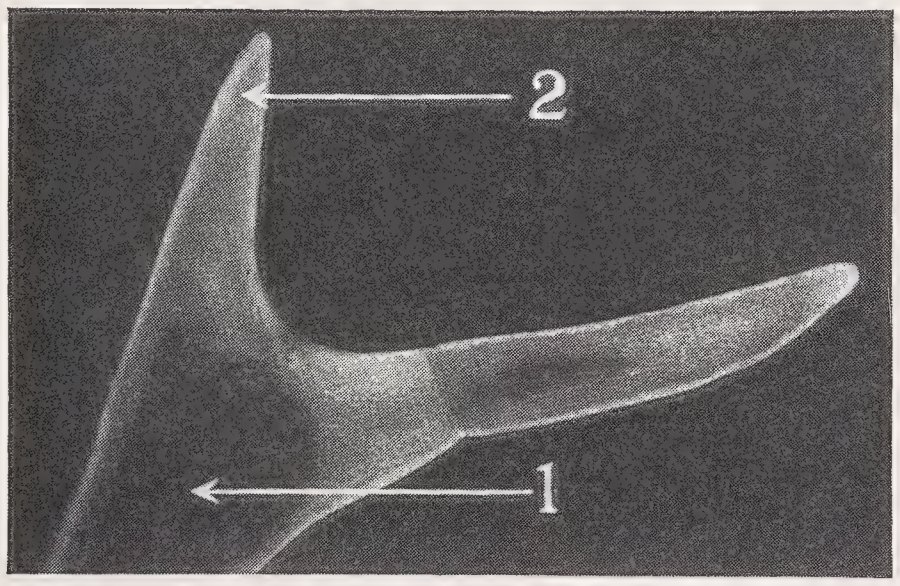


Figure 8
Completely ossified tip of the mature antler. 1. Spongy area of interior of mature antler. 2. Completely ossified tip.

From the foregoing description and discussion it is evident that the antler is a deciduous bone growth proceeding normally from the frontal bone and pedicle. If viewed from within, both horns and antlers may be considered as osseous outgrowths from the frontal bone. In the case of animals with horns or a keratogenous sheath the growth is permanent, while in deer mature antlers are deciduous bare osseous growths.

Externally, the horns have a permanent keratogenous sheath which, with the exception of the prong-horned antelope, is never shed. In the case of deer the antler has an external covering, the velvet, which is a transitory structure whose usefulness is ended upon complete ossification of the antler, after which it is shed.

[1] The Growth and Shedding of Antlers. Macewen. (Maclehose, Jackson & Co., Glasgow, 1920). Page 34.

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BULLETIN
NEW YORK ZOOLOGICAL SOCIETY



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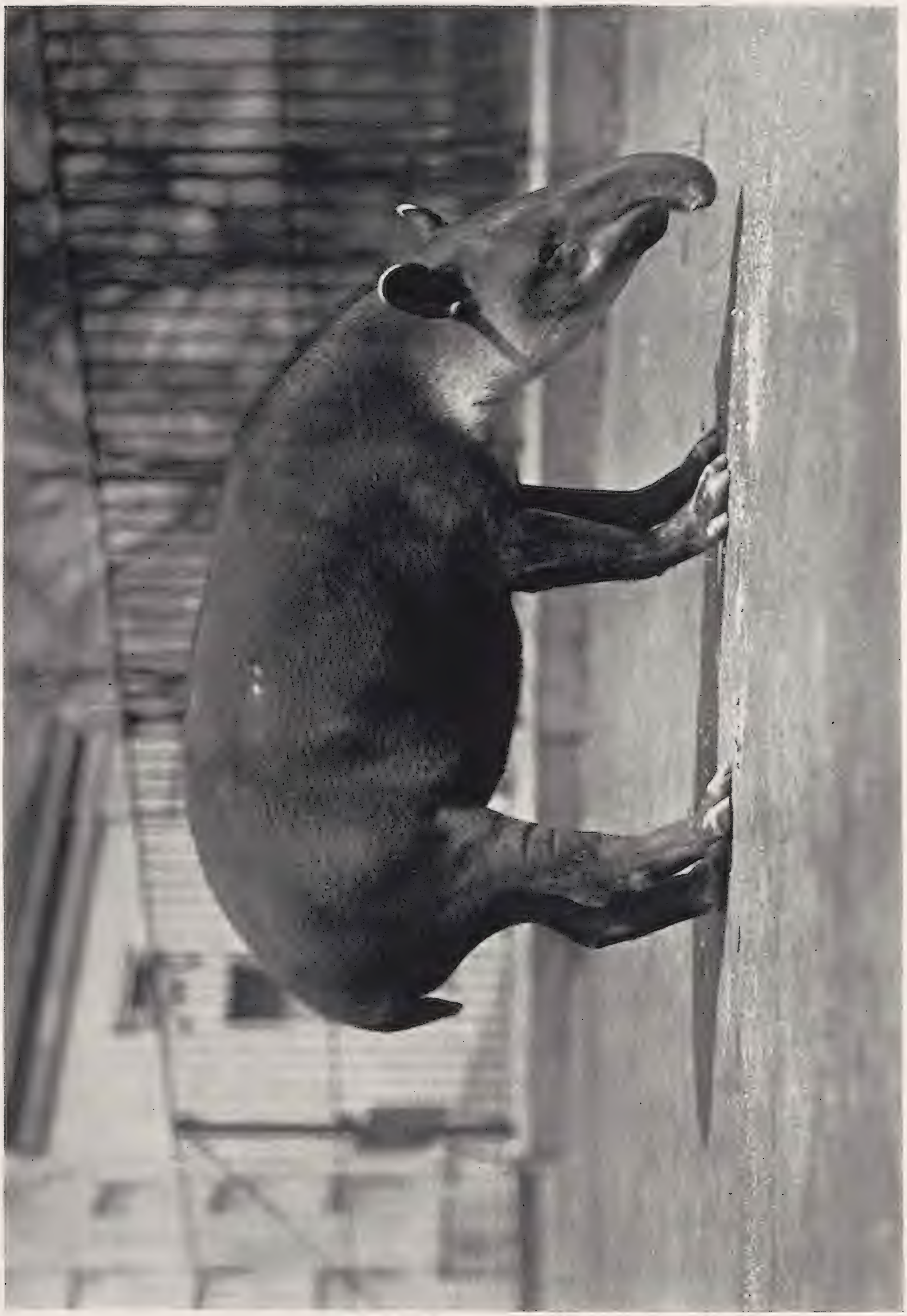
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Baird's Tapir, *Tapirella bairdi*—1929.

BULLETIN
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Tapirs, So Far As Known

William T. Hornaday

Director Emeritus, Zoological Park

Illustrations from photographs made in the Zoological Park

SEEING is believing; but seeing a tapir is not necessarily knowing all of it.

For years and years, the Malay and South American tapirs have been seen in large collections of living animals, both fixed and peripatetic; but to this day the life histories of even those seemingly familiar species remain on the same basis as that of the Baluchitheriums of the Gobi Desert, which is writable in a single line; they lived, ate and died.

And really, how much more than that does this wise world know about Baird's and Dow's giant tapirs of Central America? We know that they do live, eat and drink; that they swim and dive, marry and die. We suspect that they were born to feed hungry jaguars and hombres, and that none of them die of old age or disease; but we can not prove any of it.

Our trouble is that the three tapir species of Central and South America believe in keeping away from men and dogs, the fell Destroyers of other wild animals; and they figure it out that the thickest jungles they can find, where succulent vegetation and tepid water is plentiful and cheap, is the ideal home for them. To the hungry savage, and the equally hungry and relentless white man, a freshly killed tapir is a gift from the gods; and good men have starved to death through inability to find one at the zero hour.

In the books of jungle travel and adventure, the grand total of "Observations on the Tapir" rounds up about as follows:

"We saw a tapir on the bank. It fled into the jungle. The dogs pursued it, bayed it, and drove it into the water. It dived long, and swam well; but we killed it, and cut it up. At night we ate the whole of it, and wished for more."

This is a very truthful exhibit of the best accounts of hunting the South American tapir that I ever have seen. Eugene André, in his thrilling and satisfactory Scribner book, "A Naturalist in the Guianas," (it should be "in Venezuela"), tells about killing eight tapirs and losing one more, along the middle third of the awful Caura River, a southern tributary of the Orinoco (South Central Venezuela), while he and his party ascended that queer stream at low water. To those animals the men were just wild animals, nothing more—until they began to shoot (badly enough), and loose dogs at them. Later on, when they descended the raging Caura at high water, practically no game could be found and killed, and the whole party almost starved.

When nature fashioned the first tapir, the old dame played *Tapirus* a mean trick. She should have equipped him with horns like a mountain goat, wart-hog tusks, and claws like a grizzly bear's own. Then he would have been on an



Baird's Tapir, *Tapirella bairdi*, imm. June, 1924.



Baird's Tapir, *Tapirella bairdi*, imm. October, 1924.

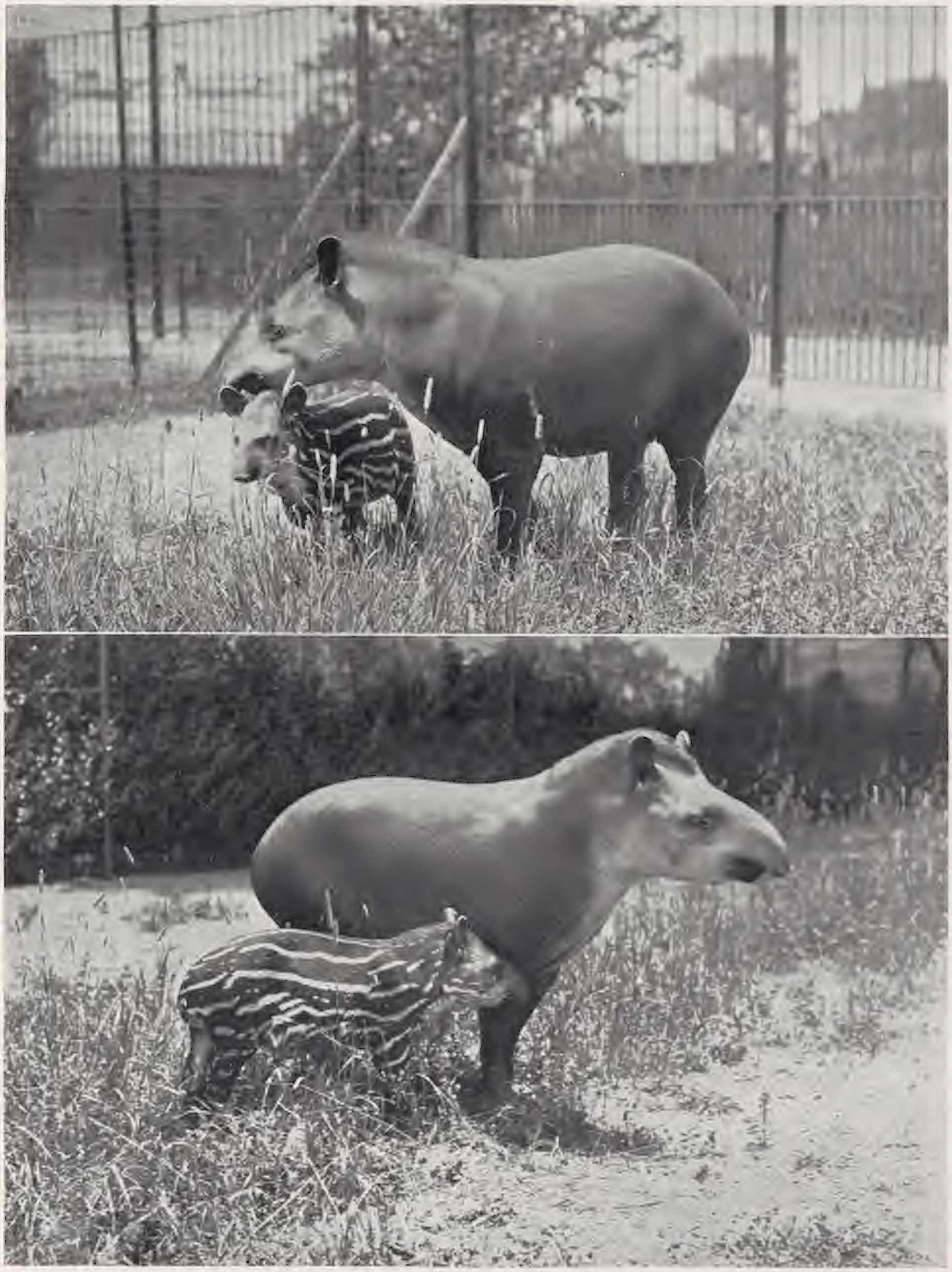


Baird's Tapir, *Tapirella bairdi*, July, 1927.

Heads of the various tapir species exhibited in the Park. 1, 2, 3, 4, Baird's Tapir, June, 1924; October, 1924; July, 1927, and April, 1929; 5, Malayan Tapir; 6, South American Tapir.



South American Tapir, *Tapirus terrestris* and young. April, 1905.
Photographed shortly after birth.



South American Tapir, *Tapirus terrestris,* and young.
Photographed July, 1908.



Malay Tapir. *Tapirus indicus.*

equal footing with the jaguar, puma, black bear, and mongrel dog. Instead of that, the poor tapir creature is like the succulent capybara—absolutely defenseless! And more than that, the low-country tapir species of Central America and India are not even good runners; all of which constitutes an evolutionary fall-down on the part of Nature. Now, if evolution is even the half of what it is cracked up to be, tell us why the tapirs of the world have not, at the very least, developed bony armor for covering, and skewer horns a la *Oreamnos* with which to puncture the tires of attacking enemies.

A typical tapir has many good points. When first captured by man it does its level best to accept and assimilate man's miserable makeshift food, until it either dies on him at the end of the fourth round, or defies him and elects to live and carry on. For himself and his owner, the period of food stabilization is the deadly period. If both parties survive it, the quadruped settles down in the good or the bad quarters supplied by the strange biped, and tries to make the best of it.

Having neither horns, tusks nor claws, the tapir has a temperament serene and patient, as becomes every unarmed pacifist. I have often recommended tapirs as household pets, because they can not possibly fight back against neglect and abuse. They start no disturbances. All they ask is 70° Farenheit, a clean bath, good housekeeping, plenty of food and not too much tapir society. It is queer, but common, for two big, lumbering Malay tapirs to flatly refuse to live together, even when they ought to like it.

There are just about four real species of tapirs, thus:

The big black-and-white Malay tapir inhabits the densest jungles of the Malay Peninsula up to Tenasserim, parts of Sumatra, and possibly Borneo; but on the last I refuse to commit myself.

The South American tapir holds forth in the jungly northern half of South America, along the river and lakes. It is of a uniform dark brown or purple color, more often found in captivity than elsewhere. It breeds freely in captivity, and endures exhibition with sang froid, even when the visiting list is at its worst. You may know it by its uniform dark complexion, and the fact that it usually has a look of having been oiled.

The big tapirs of Central America and Southern Mexico, and particularly including the Isthmus of Panama, have been for many years the least known of all the big game animals of the western hemisphere. For nearly fifty years a score or so of zoologists have known of the existence of the two big species, Baird's tapir and Dow's; but except for skeletal remains there have not been until very recently any specimens, living or dead, on exhibition to show how they look. Now, four of our large museums have mounted specimens; and others will have some, in time, as compared with Eternity.

For ten years or so we sought through the usual channels of "prominent citizens," hunters, travelers and officials, to obtain even one living giant tapir, but long in vain. Finally in Panama we hung up a fixed offer of $500 and in 1923 that price landed in New York the first living specimen that ever came to the United States. It was a funny-looking little beggar—a stocky, stolid baby that looked like a fat toy lamb covered with black-brown wool, with no white on it save the rims of its big ears. But that poor little creature had been badly used internally, its digestive organs were a wreck, and it lived only eight days.

In 1924 we had better luck. We secured a stronger and tougher specimen, and by three weeks of hard work Dr. Blair established it as a going concern. It lived, it thrived, and today it is a big, bulky beast, and large enough to afford a hundred men a square meal.

When this one arrived, it was still in its baby-striped brown-and-white coat; which reminds us to say that all little baby tapirs are rather beautifully marked with white and black horizontal bars and blotches. This "protective coloration" scheme helps to protect them from the eyes of hungry jaguars waiting on the lower branches of trees, and eye-searching the tangled jungle growth below, to see what they can find "for eat."

The two Giant tapir species (*Tapirella bairdi* and *dowi*) are roundly asserted by men who have hunted and killed them, to attain a maximum weight of 700 pounds. They are, to quite an extent, mountain-loving animals, and



Giant Horned Frog, *Ceratophrys dorsata.*

less given to hanging around rivers and lakes than the South American species. They are hard to find, and hard to kill, and usually it is impossible to find them, or to overtake them in a chase, without the aid of dogs who know the game, and play it well.

It should be noted that the South American tapir, also, is much given to frequenting jungle-clad mountains, away from water protection. On the whole it will be a good long time ere the Gran Chaco and similar fastnesses give up to "civilized" man the last of their tapirs. But the capybara is even more handicapped than the tapirs. Because they can not live on jungle-clad mountains they really must live along the river banks—or die.

The Giant Horned Frog

RAYMOND L. DITMARS
Curator of Mammals and Reptiles

Illustration from a drawing in color by Helen Tee-Van

IN the extensive family *Cystignathidae,* composed of a large number of genera represented in tropical America and Australia, are many remarkable frog-like species. Two of these are included in the series of amphibians exhibited in the Reptile House. The most remarkable is the Brazilian Horned Frog, *Ceratophrys dorsata,* recently presented to the collection by Dr. Afranio do Amaral, Chief of the Institute of Serum Therapy at Sao Paulo, Brazil. The specimen is illustrated by a colored drawing from life by Mrs. John Tee-Van.

The ten species of the genus *Ceratophrys* are great burrowing frogs, occurring from the Guianas into Argentine. Several of them have a bony shield hidden under the skin of the back, which is not, however, attached to the vertebrae. All are so brightly colored, broad of body and huge in head, with protruding, or horn-like development over the eye, as to be exceptionally grotesque—in fact, astonishing. They look more like big toys, brightly painted, than living creatures, and their habits are in keeping with their appearance.

These big frogs are actually savage. They will make short jumps at an intruder, utter barks and wailing sounds during such exhibitions—and actually bite. Such habits are unique among frogs and toads. The bite of a large *Ceratophrys,* owing to the strength of enormously developed jaws and row of sharp teeth, will pierce the skin and may be distinctly painful. I remember an illustration of this some years ago at the Reptile House in the London Zoological Gardens. The veteran reptile keeper, James Tyrrel, came out on the floor one morning with a bandage around his finger, and surprised us by saying he had been bitten by a frog. He showed us the specimen, an example of *Ceratophrys ornata,* about four inches long. The wound on Tyrrel's finger was as pronounced as if it had been inflicted by a fair-sized turtle.

In burrowing, these frogs use the shovel-shaped, bony tubercles on the hind feet in pushing aside loose soil to produce a crater and thus sink the top of the body to the surface level. Some of the soil is then thrust upward toward the back, so the creature is partially hidden. The blotched green or brownish back blends with the soil and vegetation. All of the species are markedly cannibalistic, although they also feed upon small rodents and the larger insects.

Our specimen is approximately six inches long, and nearly as broad—upon gross examination appearing nearly circular. This effect is produced by its enormously wide and blunt mouth. It spends most of the day partially imbedded in a trough of soil, but is quite active at night. It seldom goes into its tank of water. This specimen represents a species confined to equatorial Brazil.

Another member of the *Cystignathidae* in the collection is the big Brazilian Painted Frog, *Leptodactylus pentadactylus,* which has been in the Reptile House for about twelve years. This creature is a combination of bronze, brown and scarlet, laid on in bold blotches like splashes

of paint. Members of the genus to which it belongs are remarkable in laying their eggs in a small puddle, which they produce by building a wall of mud at the edge of a pond, in which the tadpoles must remain until the rainy season, when the mud walls of the enclosure are disintegrated, collapse, and the tadpoles are released.

The New Guinea Expedition

THE Zoological Society's Expedition to New Guinea returned to New York on March 21, 1929, bringing forty birds of paradise, of nine species, about two hundred other birds and mammals, six thousand feet of moving picture film and numerous still photographs.

Mr. Crandall, our Curator of Birds, left New York on August 9, 1928, and at Sydney, Australia, he was joined by Mr. J. E. Ward, an Australian naturalist of considerable experience in New Guinea. The party proceeded to Port Moresby, Papua, thence sixty-five miles west to Yule Island. From this point, the expedition penetrated a distance of about seventy-five miles into the mountains of the interior, where the birds of paradise were secured.

The total cost of the expedition was less than the $12,000 allotted for the purpose, and the value of the living specimens brought back is estimated at about $20,000. The following list includes a number of rare Australian species, secured on the return from New Guinea, as well as those collected in the latter country:

16	Lawes' Six-plumed Birds of Paradise ..... *Parotia lawesi lawesi*
2	Long-tailed Birds of Paradise ..... *Epimachus fastosus meyeri*
6	Lesser Superb Birds of Paradise ..... *Lophorina superba minor*
1	Hunstein's Magnificent Birds of Paradise ..... *Dyphyllodes magnificus hunsteini*
2	Count Raggi's Birds of Paradise ..... *Paradisea apoda raggiana*
7	Prince Rudolph's Blue Birds of Paradise ..... *Paradisornis rudolfi*
3	Horned Manucodes ..... *Phonygammus keraudrenii jamesi*
2	Black Manucodes ..... *Manucodia ater alter*
1	Blue Manucode ..... *Manucodia chalybata orientalis*
1	Black-headed Catbird ..... *Ailuroedus melanotus melanocephalus*
1	Fawn-breasted Bower-bird ..... *Chlamydera cerviniventris*
1	New Guinea Friar-bird ..... *Philemon novaeguineae brevipennis*
2	Dumont Mynas ..... *Mino dumontii dumontii*
10	Purple Glossy Starlings ..... *Aplonis metallicus metallicus*
2	Green Glossy Starlings ..... *Aplonis cantoroides cantoroides*
2	Gray-headed Mannikins ..... *Munia caniceps*
8	Parrot Finches ..... *Erythrura psittacea*
2	Gouldian Finches ..... *Poephila gouldiae*
8	Chestnut-breasted Mannikins ..... *Munia castaneithorax*
6	Diamond Finches ..... *Steganopleura guttata*
3	Cherry Finches ..... *Aidemosyne modesta*
2	Bicheno Finches ..... *Stizoptera bichenovii bichenvoii*
4	Sydney Waxbills ..... *Aegintha temporalis*
4	New Guinea Pittas ..... *Pitta atricapilla*
1	Chestnut Shrike-thrush ..... *Pitohui dichrous monticola*
4	White-rumped Wood Swallows ..... *Artamus leucorhynchus leucopygialis*
6	Yellow-breasted Robins ..... *Eopsaltria australis australis*
11	Superb Blue Wrens ..... *Malurus cyaneus australis*
6	Australian White-eyes ..... *Zosterops lateralis lateralis*
6	Black-and-white Fantail Flycatchers ..... *Leucocirca tricolor tricolor*
2	Wonga-Wonga Pigeons ..... *Leucosarcia melanoleuca*
1	Reinwardt Pigeon ..... *Reinwardtoena reinwardtsi griseotincta*
1	White-throated Pigeon ..... *Columba vitiensis halmaheira*
6	Brown Pheasant-pigeons ..... *Macropygia amboinensis cinereiceps*
2	Blue-billed Pheasant-pigeons ..... *Macropygia nigrirostris*
7	Golden-headed Fruit Pigeons ..... *Sylphitreron ornatus gestroi*
4	Painted Fruit Pigeons ..... *Ptilopodiscus coronulatus coronulatus*
1	Superb Fruit Pigeon ..... *Ptilinopus superbus superbus*
1	Lilac-shouldered Fruit Pigeon ..... *Chlorotreron iozona iozona*

2 Red-crowned Fruit Pigeons.....*Ptilinopus pulchellus pulchellus*
8 Yellow-heart Pigeons .....*Gallicolumba rufigula rufigula*
1 Black-fronted Amethyst Pigeon.....*Gallicolumba jobiensis*
1 Bustard-Pigeon .....*Otidiphaps nobilis cervicalis*
8 Stephanie's Pigeons .....*Chalcophaps stephani*
3 New Guinea Green-winged Pigeons.....*Chalcophaps indica chrysochlora*
7 Red-necked Rails .....*Tomirdus tricolor grayi*
2 Australian Stone Plovers.....*Burhinus magnirostris magnirostris*
2 Giant Laughing Kingfishers.....*Dacelo gigas gigas*
4 Blue Grass Parrakeets.....*Melopsittacus undulatus var.*
2 Cobalt Grass Parrakeets.....*Melopsittacus undulatus var.*
4 Barraband Parrakeets .....*Polytelis swainsonii*
4 Yellow-rumped Parrakeets .....*Platycercus flaveolus flaveolus*
2 Mealy Rosella Parrakeets.....*Platycercus adscitus palliceps*
2 Barnard Parrakeets .....*Barnardius barnardi*
4 King Parrakeets .....*Alisterus cyanopygius*
1 Blue Bonnet Parrakeet .....*Northiella haematogaster xanthorrhoa*
4 Crimson-winged Parrakeets .....*Aprosmictus erythropterus*
2 Blue Mountain Lorikeets.....*Trichoglossus novaehollandiae*
2 Echidnas .....*Echidna hystrix*
2 Great Red Kangaroos.....*Macropus rufus*
1 Agile Wallaby .....*Macropus agilis papuanus*

Our Black Hooded Vulture

A brief account of his capture and early training. From a letter by N. C. NELSON, *Curator of Archaeology, American Museum of Natural History.*

"THE black hooded vulture in the Bronx Zoological Park, credited to the Third Asiatic Expedition, was taken as a fledgling from the nest by Dr. Ralph W. Chaney (of the Carnegie Institution) and myself, on June 25, 1925.

"Parenthetically, I may claim to have brought "him" up and to be perhaps in some measure responsible for his gentle disposition. Everybody else in camp, including Dr. Chaney at times, despised the bird; but in the end most of them learned to appreciate his fine points.

"The vulture's home was a little west of Central Mongolia, i.e., in the northern foothills of the Baga Bogdo mountains a few miles southeast of Tsagan Nor lake. The spot is very near the intersection of 45 degrees North Latitude and 101 degrees East Longitude; in other words, 815 miles northwest of Kalgan or roughly 1,000 miles northwest of Peking. Altitude about 4,500 feet.

"We found the nest—flat and made of a large collection of sticks—on a small rock jutting out of a steep talus slope some seventy-five feet up from the canyon bottom. There were two birds on the nest when we first saw it and there were two (or more)? birds circling in the sky not very far away. When Dr. Chaney had almost reached the nest, one of the two inmates—another fledgling, we suppose—flew away. The other, "Conny," as we baptized him, was hopeless but showed signs of viciousness. He weighed, we guessed, about twelve pounds. His beak and claws were well developed; but his feathers were little more than half out and he could neither stand up nor fly. We stuck him tail end first into a duffel bag which we tied to the saddle horn and made off. The older birds meanwhile kept on soaring high above us and they followed us to the mouth of the canyon, where they finally settled on a crag.

"Conny refused boiled meat the first day but from the second, when we reached the main camp, he ate ravenously of fresh antelope, kite, fish—anything except liver—and he kept up his appetite until mid-September, when I had to turn him over to the mercies of Mr. Andrew's servants. He also drank a lot of water, especially on hot days.

"In less than two weeks the bird was able to walk about and in less than three weeks he often faced strong gusts of wind, spread his wings, took running jumps, and tried to rise. I finally clipped one wing and for a time nothing came of his attempts to fly, but by September 1st he occasionally flew across consider-



Black Hooded Vulture "Conny" on his nest, Hung Kureh, 837 miles from Kalgan; *Lower*: "Conny" and Mr. Nelson at Kholobolchi Lake, 867 miles from Kalgan, June, 1925.

able ravines and even rose and circled several hundred yards. One evening he departed in this way from camp, but was back the next morning.

"The bird very early began to show signs of friendliness and even playfulness. He waded into the lake to take his bath. He wrestled in his way with our Mongol puppy dog, and when the latter became too rough Conny paid him back in his own coin. The bird I think showed a distinct preference for certain members of the camp. However, a few days' confinement and neglect in the expedition compound at Peking changed him considerably and he became a dejected disreputable looking specimen. At that time I scarcely expected him to stand the journey to New York.

"I have twice been up to see Conny since my return last July and while I wouldn't affirm that the bird recognizes me, he certainly still seems to court human companionship."

In a later letter Mr. Nelson speaks of the altered disposition of his old friend Conny who still is living in the Zoological Park:

"I am slightly surprised to learn of the bird's temper and wonder if the keepers may not themselves be to blame. Sunday before Christmas, when Chaney and I visited the Bronx Park, we found the vulture quite ready to have his head patted and scratched, as in the old days. In the Gobi I, of course, had to handle him almost daily, picking him up to put him in his box which was lashed to the running board of the car. He cursed something awful—or so it sounded—and he often fought. Once he yanked one leg out of my grasp and closed on my hand, putting his claws almost through the palm."

Wild Life Conservation

At the annual meeting of the Board of Managers of the New York Zoological Society held on December 27, 1928, the following resolution was passed:

WHEREAS, the Wild Life Protection Society of South Africa has succeeded in having set aside 5,000,000 acres of park lands as a game sanctuary to be known as the Kruger National Park, and

WHEREAS, the objects of the Society are to bring about improvement in the observance of the laws dealing with the protection of wild life in South Africa and to use all reasonable ways and means to increase the existing species of valuable fauna and to prevent its unreasonable destruction, therefore be it

Resolved, that the New York Zoological Society go on record as endorsing this far-seeing policy of the Wild Life Protection Society of South Africa, and be it further

Resolved, that the New York Zoological Society contribute the sum of $500 to encourage and advance the objects of the South African Society.

At the Annual Meeting of the New York Zoological Society on January 8, 1929, the following resolution was passed:

WHEREAS, one of the primary objects of the New York Zoological Society is the preservation of our native American animals; and

WHEREAS, the indiscriminate killing of predatory animals without a thorough study of their value in any given area is unscientific and unfair; and

WHEREAS, the introduction of exotic species may become a dangerous factor in disturbing the balance and natural condition of our native American game, therefore be it

Resolved, that the New York Zoological Society, while recognizing the fact that a certain control of predatory animals is at times necessary, is strongly opposed to the extermination of any single species of our American Wild Life; and be it further

Resolved, that the federal government be urged to adopt for our National Parks a policy whereby all wild life should be studied intensively with a view to determine scientifically to what extent its regulation is advisable and that the policy of destroying the predatory animals be suspended until such policy has been considered, and that this Society tender its services to the national government for the purpose of aiding in the efforts to reach a proper decision, and be it further.

Resolved, that the New York Zoological Society strongly opposes the introduction of non-native animals into our National Parks and urges the National Parks Service to prohibit all such introductions.

Bermuda Oceanographic Expedition

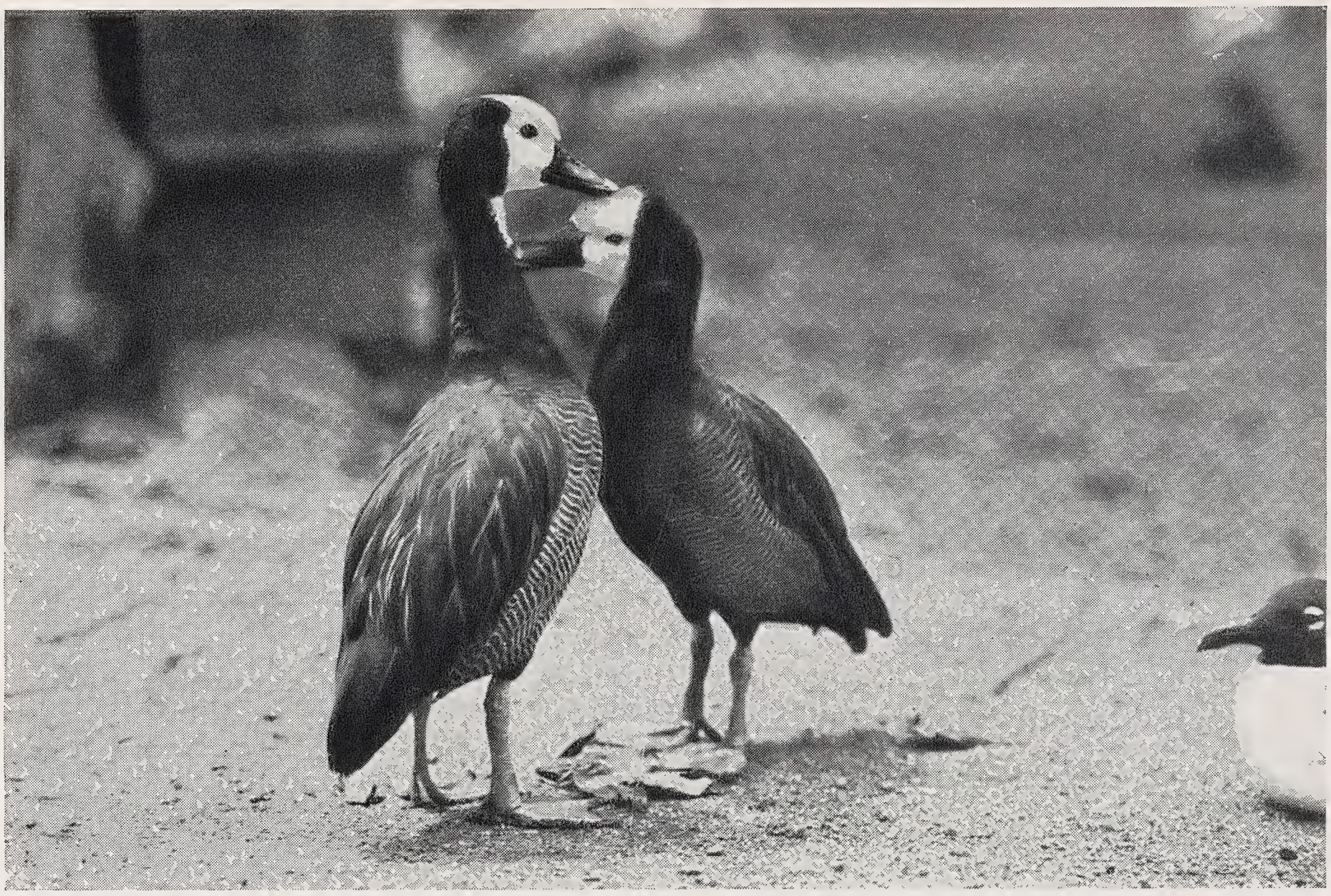
Honorary President Henry Fairfield Osborn, who recently visited the headquarters of the Society's Bermuda Oceanographic Expedition on Nonsuch Island where Dr. Beebe and his staff are engaged in the study of shore and deep sea life, reports that the work of the Station is well under way, and the results already obtained indicate the success of the expedition.

During April Dr. Beebe reported that the deep catches have resulted in obtaining ninety species numbering 3,600 specimens. In the well equipped laboratory the staff is studying the viability, color shape, activities and photographic records of the fishes. The trawling is done from three to twelve miles off shore, shoutheast of Nonsuch.

This is the 12th Expedition of the Department of Tropical Research, under Dr. Beebe's leadership, and was made possible through the generosity of two members of the Board of Managers, Messrs. Mortimer L. Schiff and Harrison Williams. W. R. B.



Griffon Vulture. The griffon is found in southern Europe and in Africa as far south as the Sudan. In South Africa, it is replaced by the smaller and grayer Kolbe vulture. Although it is a large and powerful bird, it has the cowardly disposition characteristic of the vulture and ordinarily does not attack living prey.



White-faced tree Duck. This beautiful little duck has a wide and curious distribution, being found in the West Indies and tropical South America, as well as in Africa and Madagascar. After the breeding season, it congregates in huge flocks.

The Problem of Bird Protection

Dr. A. K. Haagner

Illustrations from photographs made in the Zoological Park

IN the interests of wild-life conservation, a law has been passed in the Union Parliament prohibiting the export of all birds without a special permit from the Minister of Agriculture. This permit is granted very sparingly in regard to species not injurious to agricultural and pastoral pursuits. This law was a step in the right direction, but went much too far on the one hand, without getting at the root of the evil in bird destruction in South Africa. It was like getting hold of the wrong end of the stick. It hinders legitimate export for scientific purposes on the one hand as aviculture has certainly elicited many facts in connection with bird-lore, which had long remained obscure or even unknown. The study of birds in captivity is moreover a fascinating one, and young people should be encouraged to keep and look after their bird-friends, in the right way. It will teach them many things.

The law as it is administered in South Africa today makes it difficult to export such birds as waxbills, seedeaters and soft-billed birds, thereby making it almost impossible to carry on a legitimate trade overseas, whereas on the other hand thousands are caught with birdlime in every district, and more often than not are allowed to die for want of proper attention, while thousands more are caught in snares and shot with catapults, air guns and saloon rifles. The little native herd boys capture and otherwise destroy large numbers of *useful* birds, which they eat. They rob the nests of the half-fledged nestlings and devour these little creatures quite oblivious of the anguish of the unfortunate parents. As a case in point, take our beautiful lilac-breasted roller (*Coracias Caudatus*). This bird was at one time fairly common throughout the Transvaal bushveld, and especially so in the Pretoria District. It has been on the protected list of birds for a considerable time, but this has not prevented its



Eared Vulture. In Africa, flocks of vultures gather to feed on the carcasses of game and cattle. The eared vulture is the largest of these birds. Because of its size, strength and aggressive disposition, vultures of other species stand in awe of it and maintain a respectful distance until the "king" has eaten its full.

gradual extermination, nor will the export prohibition law help it one jot. The little native herd boys have nothing to do all day long but set snares, hunt for nests, etc., and the toll they take is enormous. One Sunday in the bushveld, forty miles north of Pretoria, I came across two little black boys with four rollers in their possession, which they were busy plucking, preparatory to roasting over the coals. The game and bird protection laws are almost unknown to the natives, and even if they did know them, it would make very little difference. How are we going to control these laws in the "backblocks" where the police are few and far between? While these lovely birds are being decimated by the natives, the dealer has great difficulty in obtaining a permit to export—we will say—half a dozen pairs of a species.

It has been suggested that a law be enacted preventing the keeping of birds in cages. I have kept birds for many years, and whenever one or more escapes these seldom leave the place, but remain in the vicinity of the aviary until recaptured. These birds would appear to be perfectly happy in their captured state. I am of course opposed to keeping birds in too confined a space or in a semi-starved condition. I am also against the wholesale and promiscuous catching of birds going on at present. I think that this should be under control, only suitable and reliable men being allowed to catch birds, —men who know how to catch, handle, feed and transport their little feathered captives. If it were made compulsory to take out a permit to capture birds, the town-boy and country native, who has no real interest or knowledge of birds, can be eliminated to a certain extent. I say to a certain extent advisedly, as South Africa is a country of wide spaces sparsely populated, and meagerly policed, and it is next to impossible to control the whole country efficiently. This we know from our experience in the operation of the game laws.

Much has also still to be learned regarding the true economic status of many of our birds. Mr. Fitzsimons, the Director of the Museum in Port Elizabeth, a man who has written much on the subject of bird protection in South Africa, informs me that the bird life generally has decreased much during recent years in that locality. It certainly has done so in the Pretoria district, except in a few favored spots, such as the Fountains Valley, the Zoological Gardens grounds, and on the hills adjoining the townlands, where birds have been more or less protected by enactment and by private people.

With increasing agricultural activities a lot of the wild cover frequented by birds has disappeared. Bush has been cut down and swampy ground drained to make room for the plough, and thus much of the natural cover loved by birds has been destroyed. With the increase of cultivated fields, certain birds have increased, 'tis true, but these comprise hardy species, such as the weaver birds, which do an appreciable amount of damage to the ripening grain crops and are in consequence not much loved by the farmer.

A peculiar phenomenon I have noticed from time to time is an occasional increase in the bird population of one species, followed often by a corresponding decrease. This applies to seasons, to particular districts, and even to the country as a whole. What was the reason for this increase and decline in numbers? In the case of the South African griffon vulture (*Gyps kolbei*) the reason may be explained by the sudden increase in the food supply and subsequent falling off of this supply. During the Boer War and during the time of the rinderpest (a scourge which decimated the bovine herds in South Africa) the food supply increased enormously, which upon the conclusion of the hostilities on the one hand and of the epidemic on the other, has suddenly decreased. But this explanation will not hold good for other cases I know of, except the increase of locust-eating birds during the period of invasion of swarms of these insects.

The southern ostrich, in its wild state, is still found in the Pretoria Bushveld, where there are fairly large tracts of unfenced country. For the rest it has betaken itself to the wilder parts of the country—the northern Cape Province, Bechuanaland, Northern Transvaal and Rhodesia.

The wild ducks of various species seem to have become scarcer during the past few years. I have been residing near a river now for the past twelve months, which has two dams, and all the ducks I have seen were a few black



South African Ostrich. Africa boasts several forms of ostrich. The South African species, distinguished by its dark blue legs and neck, is the smallest of all. Nevertheless, it is the most valuable, and was once kept in great numbers on farms devoted to the purpose. Dame Fashion is again smiling shyly at the ostrich plume and the industry of former days may be revived.

duck (*Anas sparsa*) a couple each of yellow-billed and redbilled teal (*Anas undulata* and *Anas erythrorhynchus*) and about a dozen white-faced tree ducks (*Dendrocygna viduata*). Wild duck of various species are still found in fairly large numbers on many of the big inland waters, and even on large dams and vleis. The Pratincoles (*Glareola*) are nothing like so numerous as they used to be (at least I have not seen many during recent years) and yet they have long been on the protected list. Another fairly scarce bird in most localities is the blacksmith plover (*Hoplopterus armatus*). A pair have taken up their summer residence on a spruit (rivulet) about half-way between Hammanskraal and Pretoria (about fourteen miles north of the Capital), where they are evidently breeding. The common crowned lapwing (*Stephanibyx coronatus*) is also not so plentiful as it used to be.

The bustards, I am told, have multiplied considerably on the Orange Free State "flats" since they have been protected. This is, however, not the case in the Transvaal. The red-crested bustard or bush koraan (*Lophotis ruficrista*) has become much scarcer in the Pretoria District, although protected by law. The cranes are becoming very much less in number, the wattled or bell crane (*Bugeranus carunculatis*) being seldom seen nowadays. Even the once common blue or Stanley crane (*Tephtrapteryx paradisia*) is not always procurable today, and is seldom seen in flocks of from eight to sixteen individuals—a not uncommon sight twenty years ago—yet these have long been on the protected list. It is, however, being constantly persecuted by the natives as it is easily trapped and forms quite an excellent meal.

I have already mentioned the common vulture. The black or eared vulture (*Otogyps auricularis*) seems to have become scarcer than ever. It never was a common species.

Owing to the fact that so many of the South African birds are partial migrants or "district" migrants, it is not easy to give an opinion as to which species have become scarcer and which more numerous, except in a few instances.

This is particularly the case with the hawks and owls and most of the Passeres.

The barbets appear to have become scarcer, but not so the colies or mouse birds. I have already mentioned the lilac-breasted roller. The other species of the roller are much scarcer, generally speaking. I have seen two specimens of the European roller, during the ten months I have been at Hammanskraal. The hornbills are still fairly common, especially the yellow-billed (*Lophoceros leucomelas*). Kingfishers have become very scarce in some localities, a fact I cannot account for. In others they are quite common. Crows have become scarce in some districts, but appear to be still fairly common in others.

Some of the smaller birds, including seed-eaters and waxbills, have become a little scarcer, but not to an appreciable extent, except in a few districts where the natural conditions are not so favorable as they used to be.

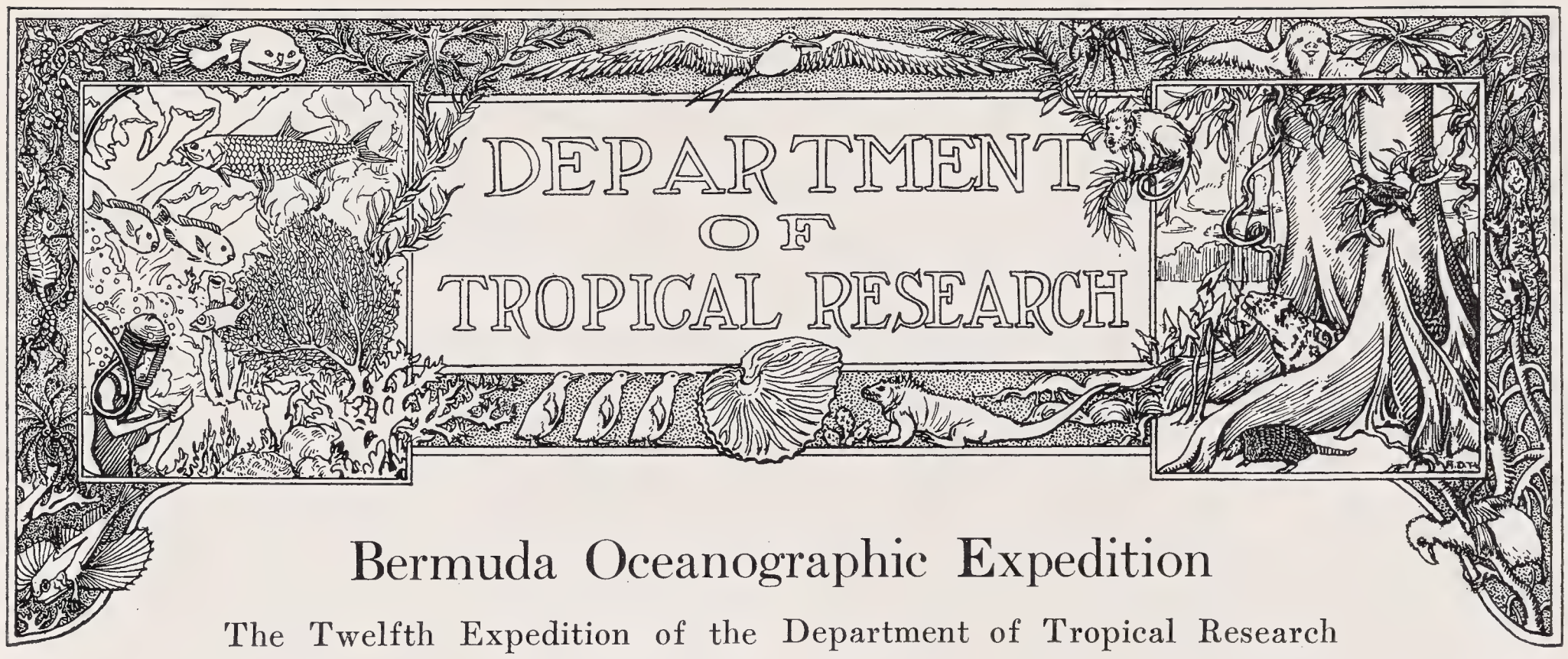
Still there are spots nearly denuded of bird life, which would appear to be suitable enough for many varieties. The cause of the absence of bird life is often very obscure, and much yet remains to be done in the intensive study of the general distribution and economic value or status of our avi-fauna.

The oxpeckers (*Buphaga*) have become rare, and the reason for this was, to a certain extent, explained to me by a farmer-friend of mine, who puts this down to the dipping of the cattle. The birds devoured the arsenical dip-impregnated ticks in such numbers that the dip killed off the birds in no time. The explanation seems feasible enough, although it is not so apparent with other species, such as the buff-backed egret (*Bubulcus lucidus*). These birds are still fairly common between here and Pretoria. I have recently seen flocks on the road in at least two localities.

With reference to the export and destruction of birds, another case has just been brought to my notice, viz., that of the red-headed or Nyassa lovebird, in Rhodesia. The Government restricts and has tried to stop the export, but I understand from Mr. Mackenzie Walker, of Chomo, that the species is very common, occurring in large flocks along the Zambesi River and other favorable localities, where the natives trap and catch them in thousands and eat them. They are very destructive to crops, especially Kaffircorn and millet.



Paradise Crane. All of the cranes are noted for their grace and beauty but the Paradise or Stanley is much the finest. The long, drooping secondary feathers of the wing are so extended that they drag upon the ground.



Bermuda Oceanographic Expedition

The Twelfth Expedition of the Department of Tropical Research

ON March 13, Dr. William Beebe, with seven members of his staff, left New York on the S. S. *Fort Victoria* of the Furness Line, bound for Bermuda where they will carry on work in the field for six months.

H. E. The Governor Sir Louis Bols, the Honorable F. G. Gosling and the Legislature of Bermuda have granted to Dr. Beebe the use of the Island of Nonsuch as a base for deep sea work off shore. The financing of the Expedition, aside from salaries, has been assured by the generosity of Mortimer Schiff, Harrison Williams, Burt Massee and other gentlemen.

The island of Nonsuch consists of 25 acres, partly wooded with ancient cedars, with alternating coral rock and sandy beaches, and is provided with buildings in perfect condition for use as laboratories. Directly off shore, deep water approaches closer to Bermuda than elsewhere, a mile depth being found only two and a half miles beyond the one hundred fathom mark. With the sea-going tug *Gladisfen,* daily trawling in from one to two miles of water will be carried on for many months, and by the aid of pressure tanks, dark rooms both on the tug and on shore, and a fully equipped laboratory, the abyssmal fish will be studied, both alive and dead.

The efficiency of carrying on this work from the deck of a tug was demonstrated by Dr. Beebe during the past summer in the Hudson Gorge, and the richness of the deep-sea life in the particular area off Bermuda was proved several years ago by station hauls of the *Arcturus.* After a thousand net hauls have been drawn in the deep sea off Nonsuch, these should result in considerable definite knowledge of the life histories of organisms and the general ecological conditions existing in this black, cold, high-pressured and almost unexplored field of life.

The fish life of the reefs and shallow water will be studied intensively with the aid of diving helmets, submarine cameras and a fleet of six boats, while constant observation will be carried on of certain limited areas of coral reefs, within a few yards of the island. Laboratory work will be confined to observations bearing directly on life histories and ecological associations, and such problems as the osteological development of larval and young fish.

Among the members of the staff are the following:

William Beebe, Sc.D., *Director;* John Tee-Van, *General Assistant;* William K. Gregory, Ph.D., *Scientific Associate;* Dr. C. J. Fish, *Scientific Associate;* Mrs. C. J. Fish, *Scientific Associate;* William Merriam, *Field Technician;* Gloria Hollister, B.S., M.A., *Technical Associate;* Mrs. Hayne Boyden, *Laboratory Assistant;* Helen Tee-Van, *Artist;* Sven Von Halberg, *Field Assistant;* Robert Whitelaw, *Photographer.*

Professor and Mrs. Henry Fairfield Osborn will spend the month of April with the expedition, and among other well-known scientists or visitors will be Prof. E. Newton Harvey, Prof. Sayles, Dr. Mees, and Mr. V. Drake.


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Figures described in the text.

The Architectural Beauty of Fish

New Adaptations of an Old Method

WILLIAM BEEBE

Illustrations from photographs by William Beebe and John Tee-Van

WHEN I was a student at Columbia, I first began to try experiments with the well-known Schulze technique of clearing tissues and staining skeletons, a method which has been used successfully for many years by Dr. R. M. Strong of Chicago and others. For several years in my department we have been making translucencies (to coin an appropriate word) of deep and shallow-water fish. Not, however, until the last twelve months has this method been developed in my laboratory to that really satisfactory point, when the final results deserve the word of transparencies. Miss Gloria Hollister, Technical Associate of the Department of Tropical Research, after months of intensive experimenting has prepared several hundred specimens which are as perfect as could be desired. The scales, flesh and internal organs of the fish are perfectly transparent, and the bones of the skeleton appear in their proper places stained a glowing scarlet—the most delicate of ossified centers and slivers standing out with brilliant clarity. Very recently the same success has attended the staining of cartilage. The clearing technique in reptiles and birds is a comparatively simple matter (Figures 1 and 2) but the cartilage of most fish is resistant to vital stains to a discouraging degree.

Figures 3 and 4 illustrate the extreme achievement in this clearing method. Figure 3 is a specimen of the Amazonian Wingfin, a fresh-water tropical fish, *Pterophyllum scalare.* Figure 4 shows the same after clearing and staining. The rapidity with which results can be attained with careful manipulation of our readaptations of this method is astonishing. Figure 5 shows a young Triggerfish, *Monacanthus,* entire except for the removal of the eyes, forty-eight hours after its capture in the waters of Bermuda. It must be realized that these photographs are in no sense X-rays but are of actual specimens permanently preserved in glycerine.

Figure 6 is a young, deep-sea Viperfish, *Chauliodus sloanei,* from a mile down, with the anterior part of the backbone just beginning to show bony substance. After being cleared it was discovered that the fish had swallowed another fish—a *Cyclothone*—almost as large as itself. The head of this engulfed fish was, in its turn, outlined in scarlet. From the number and arrangement of the light organs on the body of the victim it is possible to tell the species and even the subspecies—*Cyclothone signata signata.*

An enlarged and cleared head of one of these *Cyclothones* is shown in Figure 7, where the eyes, stomach and backbone are clearly seen, as well as the marvelously elongated and attenuated bones of the head. These are adapted, to a much greater degree even than in a serpent, for permitting the opening of the jaws to the widest extent.

Figure 8 is *Sternoptyx diaphana,* a silvery, highly illuminated fish in life, living about half a mile beneath the surface. The cleared body as shown in this photograph appears filled with a beautiful filigree of slender bones, and reveals the strong strut which supports the transparent area of the lower portion of the outline. Of the function or use of this hyaline bit of what should be part of the actual body of the fish, we are wholly ignorant.

A baby deep-sea Flounder (Figure 9) is an architectural joy, palisades of needle-like cartilage bounding the as yet unhardened backbone. The necessary bones of the head are, even at this age, strongly ossified, while an almost complete halo about the body, of bony fin-rays, shows how important are these structures to the life of the immature flatfish. A greatly enlarged view of the head (Figure 10) reveals each element, either clearly formed and functioning, or faintly adumbrated in cartilage.

Finally I show photographs of two deep-sea fish which I have been studying in detail. In Figure 11 are seen the slender bones of a cavernous-mouthed *Melanocetus,* or Black Whalelet









Figures described in the text.

of the deeps, with its brilliantly illuminated beacon suspended on the tip of a long tentacle, and the huge mouth furnished with serried teeth. The pukka body of this fish is a mere posterior fraction of the whole.

The last photograph is the side view of a new species of *Haplophryne* (Figure 12) recently brought up from the depths of the Hudson Gorge, and showing every detail of the skeleton. A monograph of this species will soon be published in Zoologica. Around the whole fish can be faintly discerned the strange, thick, balloon-like external envelope of skin in which it is encased. Notice especially the separate elements of the skull, the curious, detached, dermal denticles at the front of the upper jaw, and the diminutive but perfect tentacle extending far out from the forehead, but still beneath the outer skin surface. In sharp contrast to the fish in Figure 4 this species shows no signs of ribs, and only the tail fin is thoroughly effective in locomotion, the others being for the most part embedded in the outer tissue envelope.

With the whole process reduced to a period of much less than a week, and with both cartilage and bone stained—the one blue and the latter scarlet—and the body tissues made as transparent as the glycerine in which the fish floats, new and interesting discoveries concerning specific development and systematic relationships are being easily and accurately made. Dr. William K. Gregory and I have spent many evenings in enthusiastic study of the various cleared forms. It is a means which is of value to scientific research, as well as a thing of artistic beauty, appealing even to the persons to whom the only use of a fish bone is to keep it out of one's throat.

Fishing a Mile Down in the Hudson Gorge

WILLIAM BEEBE

Illustrations from photographs by William Beebe and John Tee-Van

THE best known Hudson Terminal is a tunnel in lower New York about a year and a half old. The original Hudson Terminal is a canyon, one hundred miles south-east of New York City, lying one mile below the surface, and excavated about a million years ago. Long after the last animal and insect from the heart of Africa and New Guinea has been collected and named, and the north and south poles have been crossed and recrossed with tourist planes, strange fish and other creatures will still be brought to light within a day's motor boat run of New York City.

I had to spend most of the summer of 1928 in New York City, and yet I longed to be exploring on the edge of known things. How could I manage both at once? There came to mind a cartoon in which Skippy and his small friend stand for a long time gazing out to sea. Throughout three layers of cartoon strips not a word passed between the two urchins. At last, without turning his head, Skippy said, "You know, that's only the top of it."

That cartoon set me thinking, and brought to mind the Hudson Gorge, silent, black, cold,—with its sunken vastness filled with unknown forms of life. If I could manage to find transportation one hundred miles from land, and means for reaching down even a half mile I could explore without neglecting my laboratory researches in the City. My thought spread and took fire in other minds and one day in early July I found myself on an ocean-going tug, backing out of a Brooklyn slip, on the way to test my newly-thought-of world. The tug was the *Wheeler* and the god-in-the-machine was Mr. L. F. V. Drake, President of the Salvage Process Corporation. Mr. Drake is now a life member of the Zoological Society and keenly interested in every phase of our undertakings.

Twenty-five thousand years ago I could have walked the hundred miles out to sea dry shod, for at that time there was so much water locked up in ice on the continent that the ocean's level was more than three hundred feet lower than now. Ages before this, the Hudson, fed by five river-tributaries, had cut its way still farther, through a valley now deep beneath the surface,



Firola; a deep-sea mollusk eight inches long which has lost its shell and developed a fin for swimming.

and through a gorge with water-falls higher than anything on earth today.

We start in the evening and on the first trip sleep but little for there is a magnificent display of northern lights—flashes and ribbons and radiating spokes of yellow and rose and green. At eight o'clock the next morning the little tug is rolling gently on the threshold of our New York mystery—something more than one hundred miles out at sea, with the blueness of mile-deep ocean stretching all around to the rim of the world. The only life on the planet is our tugful of selves and a quartet of Mother Carey's chickens.

My small *Arcturus* winch is uncovered, given a breath of steam, and the wire begins to uncoil. To it a series of great silk nets is fastened, and they go billowing back in the wake, settling slowly out of sight. A mile and a half of wire is run out and for several hours we crawl along at a speed of two knots.

I put my hand on the taut, vibrating spider web of steel, my eye follows it down into the sheer liquid ultramarine, and I pray to Neptune, or perhaps better to Slid—god of the uttermost deep—where, it is said, "he may sit and smile, or creep among the ships, or moan and sigh round islands in his great content."

In a metal helmet I have walked in comfort ten fathoms down, and once a diver in full suit touched forty-six fathoms and came back alive. But the rest of the under water world is hidden, and for the present, the North Pole is far more accessible than where my nets are trailing.

I wave my hand, the bell in the engine room clangs, the propeller rests and the sturdy bulk of the tug begins to rock, swinging to the wind. Slowly the wire reels in, and finally the great nets, bulging at their apex, come dripping aboard.

Into big jars and aquariums flows the pink treasure, glittering and gleaming, trembling with strange vitality, every spoonful a cosmos of hundreds of living beings. There looms through the translucent mass a long black and bronze snake, or eel, or as it finally proves a scimitar-fanged sea-dragon. I pick it out and at the first touch feel almost pain from the bitter cold. In the heat of a quiet July day, my hands become numb as I dip them into the living gelatine, and the mysterious character of this deep world begins to shape itself in my mind.

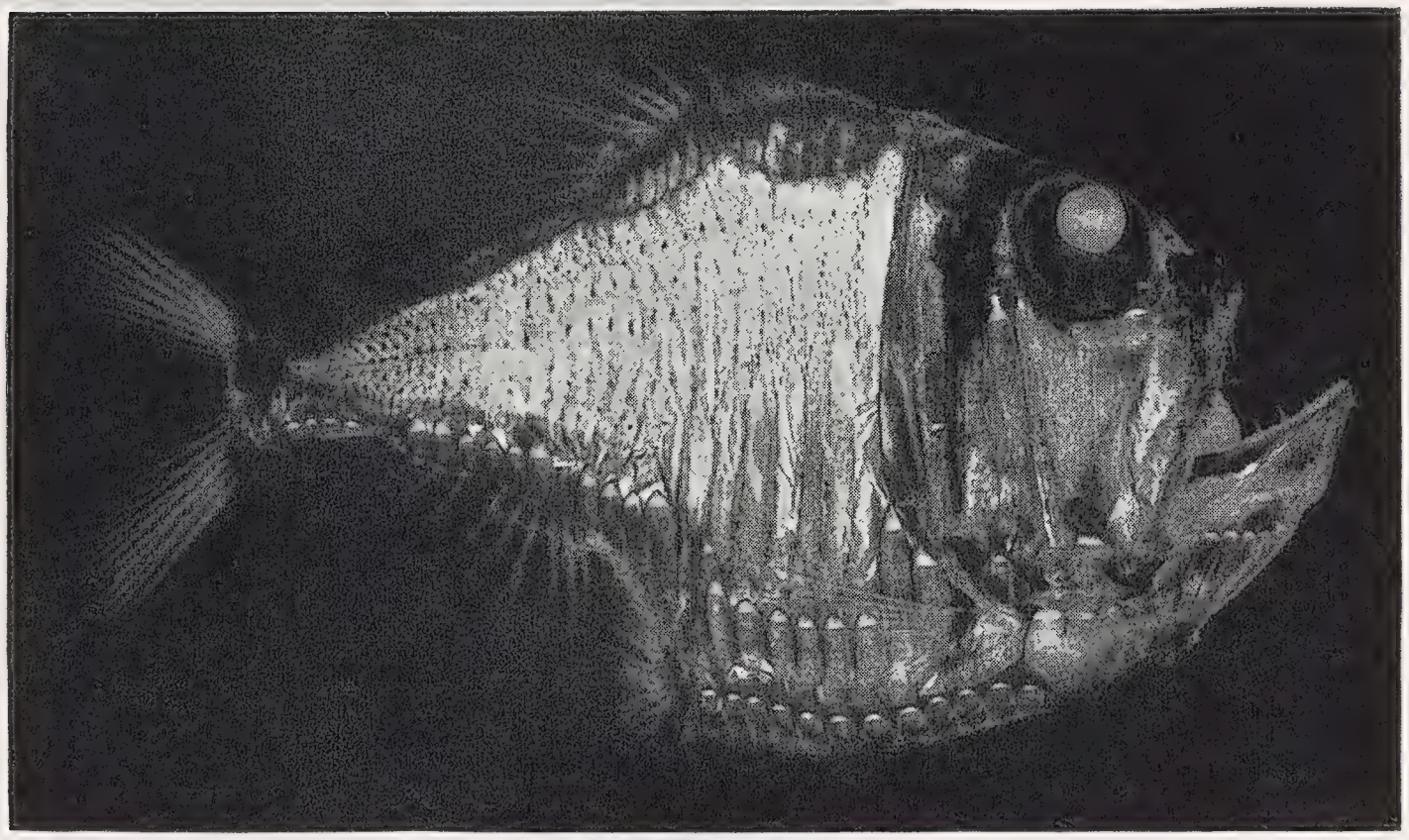
At the surface the water is 68°, five hundred fathoms down it is 40°, and at the bottom of the Hudson Gorge the thermometer records 31°. This would be impossible in lake or river, where the fresh water turns to ice at 32°. As I pick up the dragon fish, the mouth opens unbelievably wide, as wide as the gape of a sabre-toothed tiger, and the long, needle-like teeth come together with a snap. I had wondered how such teeth could be managed, and I now saw that the two longest went straight through concealed holes in the head and appeared above the skin near the eyes. A long tentacle thread from the dorsal fin drooped forward in advance of the head—a feeler recalling the portiere of dangling cords which warns freight crews of the proximity of a low tunnel or bridge.

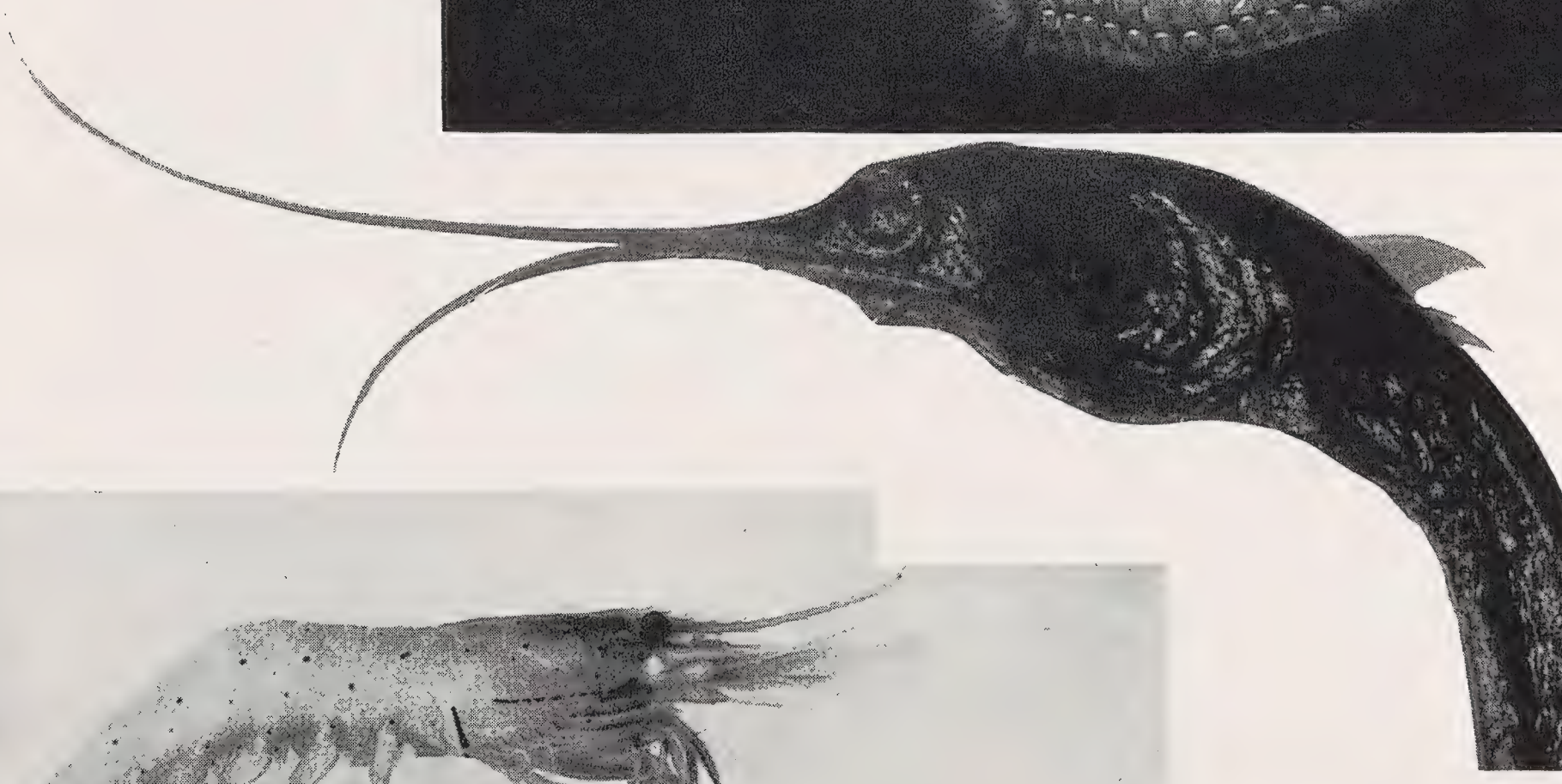
Several large shrimps drew my eye like magnets, for they were of the most intense, vibrating flame scarlet conceivable. I put one into a small glass, ran down to a dark cabin, shut the door and watched magic. Little by little from out of several pores there flowed a fluid within fluid—a foggy mist sifting and billowing through the water, a mist which suddenly took fire and in the darkness I saw I was holding a glowing glass—the water alight with soft radiance. As a squid escapes through his own sepia smoke-screen, so this deep-sea shrimp was covering his tracks with a dazzling cloud of flame. A second realization came to me—the utter darkness of the path along which the net had come. Sixty feet below the surface I have watched fish swim in what seemed brilliant tropical moonlight, while at two hundred fathoms submerged photographic plates tell us the illumination is of the strength of starlight. But the twilight of the depths is not the gloaming of land, for as we descend beneath the waters the red goes first, indigo and violet last. So, at his great depth, my scarlet shrimp would be as black as black—there being no red rays to reflect from him. In fact, until I brought him up he was *not* and had never been red.



A deep-sea squid, deep maroon in color, with several thousand glowing spots of light.

Argyropelecus or hatchet fish, gleaming with a skin of silvery tissue, lighted with clusters of various colored lights.





Snipe-billed eel from a mile down. The function of the jaws is unknown.



Acanthepyra, a scarlet shrimp from zones of darkness. When frightened it pours forth a blazing, luminous cloud of phosphorescence, dazzling its enemies and escapcaping through the glowing mist.



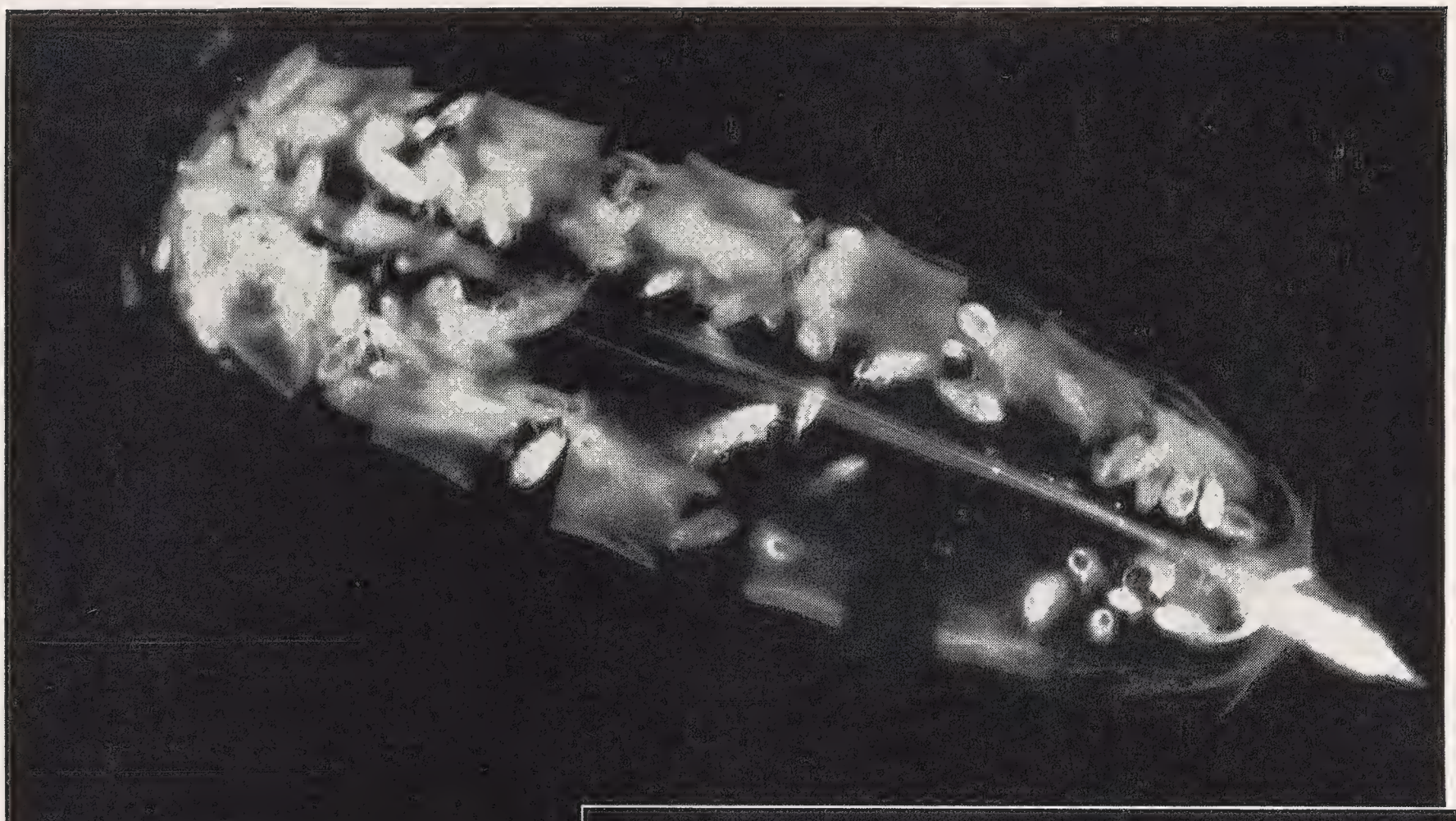
Melamphaes, jet black with turquoise scales; dwells far below the zone of sunlight.



A true sea-dragon, the fish known as *Chauliodus sloanei*. Although it is but thirteen inches long, it is a dreaded foe by all fish near its size.

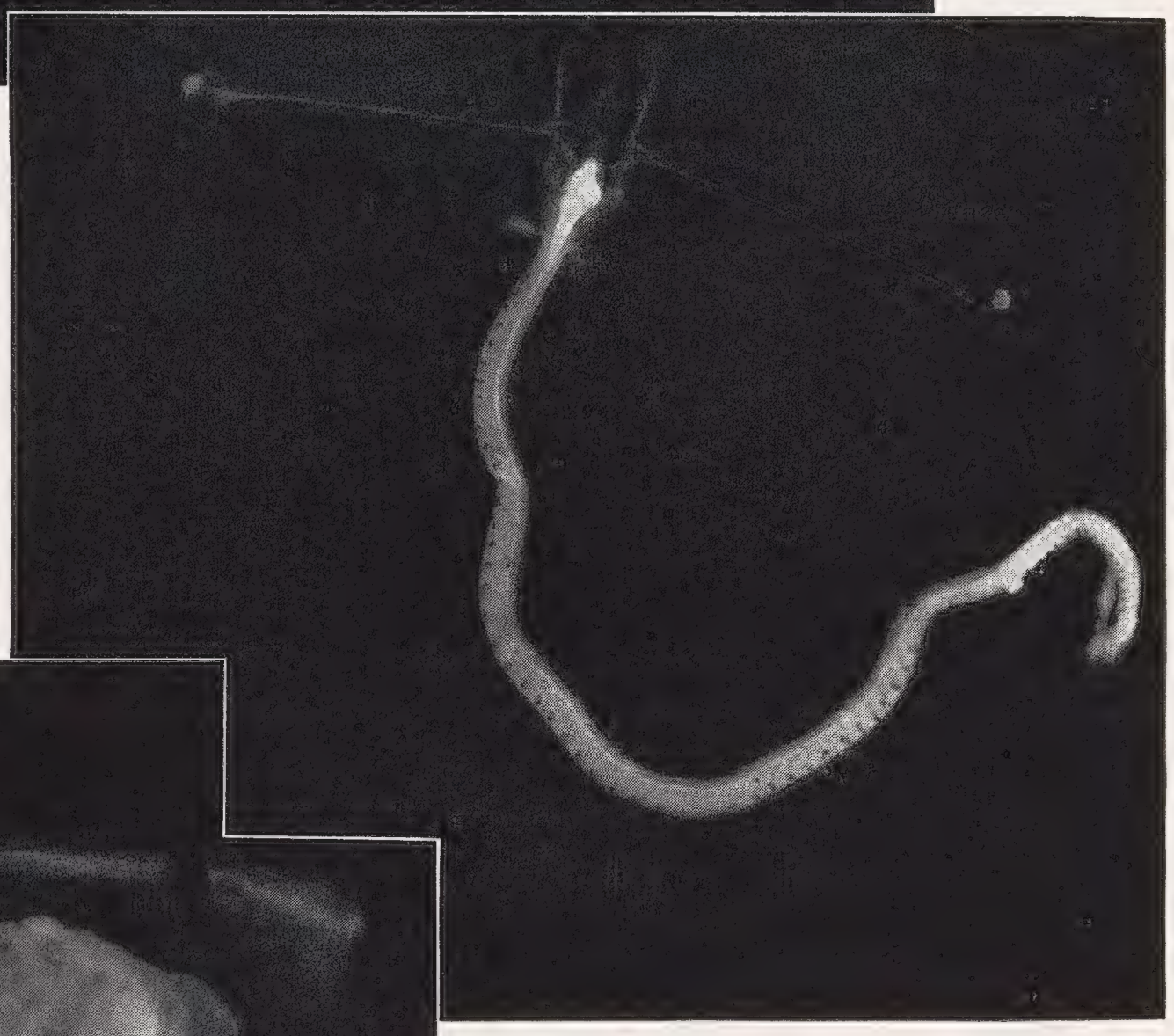


Sabre-toothed viper-fish of the black depths of the Hudson Gorge.



Salpa zonata. A single glassy segment of a long string of living creatures. One of the failures that made a futile attempt to develop as a back-boned animal.

Stylophthalmus, strangest of living fish, with pale thread of a body lined with scores of glowing portholes, a beak like that of a duck, and eyes on the tips of enormously elongated stalks.





A shrimp which rears its young inside the glassy barrel home of another animal, thus protecting her offspring from ravenous sea-devils.

We think of the blackness and we look at the great teeth, and a connection at once occurs to us — plants cannot grow without sunlight, so, far beneath the surface, every creature is carnivorous. We know indeed that some are confirmed cannibals, and many have stomachs so elastic that they can swallow a fish several times their own length.

If absolute and perpetual midnight should suddenly envelop our city, only those of us could survive who had access to adequate illumination, or who by blind skill could manage to avoid danger and find food. As we study our deep sea creatures we learn that the same thing holds good in the gorge of the Hudson. Many of the fish and shrimps and squids are covered with powerful searchlights, or dotted with lesser beacons, and their eyes are large and all-seeing. In others we find long feelers reaching out in all directions and blind or nearly blind eyes. As a blind man hangs a lettered sign about his neck—a sign he himself can never read—and sits patiently waiting for it to attract pennies, so occasionally we find a blind fish with the sockets of its eyes turned into glowing headlights. We can explain it only as a lure to draw small victims close enough for some other sense to detect them.

The flabbiness of the fish, their relaxed bodies and loose scales remind us of the gentle pressure upon our own bodies compared with that which exists at great depths. A mile down, the water bears upon every inch of surface with the weight of a ton, and only because we have brought them up so slowly are the fish still alive and in fairly good condition.

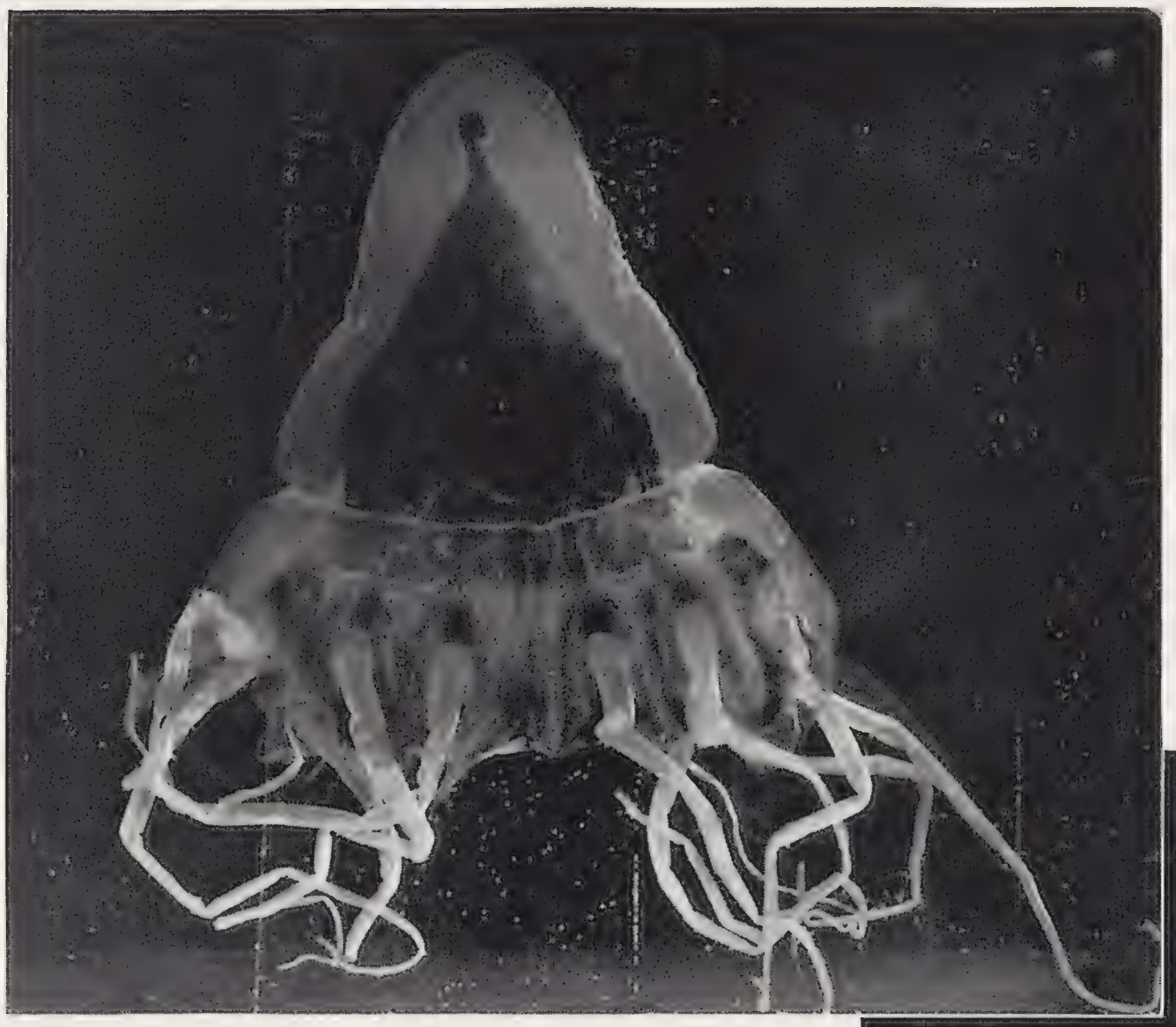
In every net there are hundreds of unsolved problems. A tiny white thread of a fish has perfectly good eyes far out on the end of impossibly slender stalks, each half as long as the body, a boon indeed for the watcher of a parade, but in our present ignorance of no conceivable use to the fish; another fish is round and of glowing silver, and has all its batteries of green and violet lights turned downward while it forever stares immovably and piously upward; a third fish has series of great curved teeth along the jaws, but outside at various angles on the skin, where they seem utterly useless.

Now and then we see something which needs no explanation, but demands only appreciation and wonder; a curious, pale violet, humpbacked shrimp with a brood of tiny humpbacked offspring. All are gathered on the inside of a transparent, fluted barrel which the mother has taken from its original owner, and, like a more unselfish Diogenes, used it for a nursery. With her swimmerets she is able to kick her house along so that a stream of water and food pours through. Though hosts of hungry dragons may nose about the sides (we can scarcely say that their mouths water) yet the shrimp and her brood are safe. The courtships and battles, the comedies and tragedies of family life in this underworld will some day yield delightful tales of ingenuity, horror, and devotion.

With all this strangeness there is also beauty beyond words. In and out through the mass of life swim active opals—gleaming and scintillating as they twist and turn—tiny, oval, living tissues of flame and ash, which glow as brightly after death, for their colors are due not to pigment but, like a hummingbird's throat, to a myriad prisms.

With our present meagre facilities we can best revive the glories of the sea depths by taking the new caught beings into a darkened room, and watch the shift and play of colored lights, the lines upon lines of glowing portholes, each beacon as complex as an eye, with lens and reflector; other lights arranged in certain patterns along the sides are perhaps for recognition by members of the same school, and finally, we watch the penetrating flashes which, as they are different in the two sexes, may be of use in finding and securing a mate.

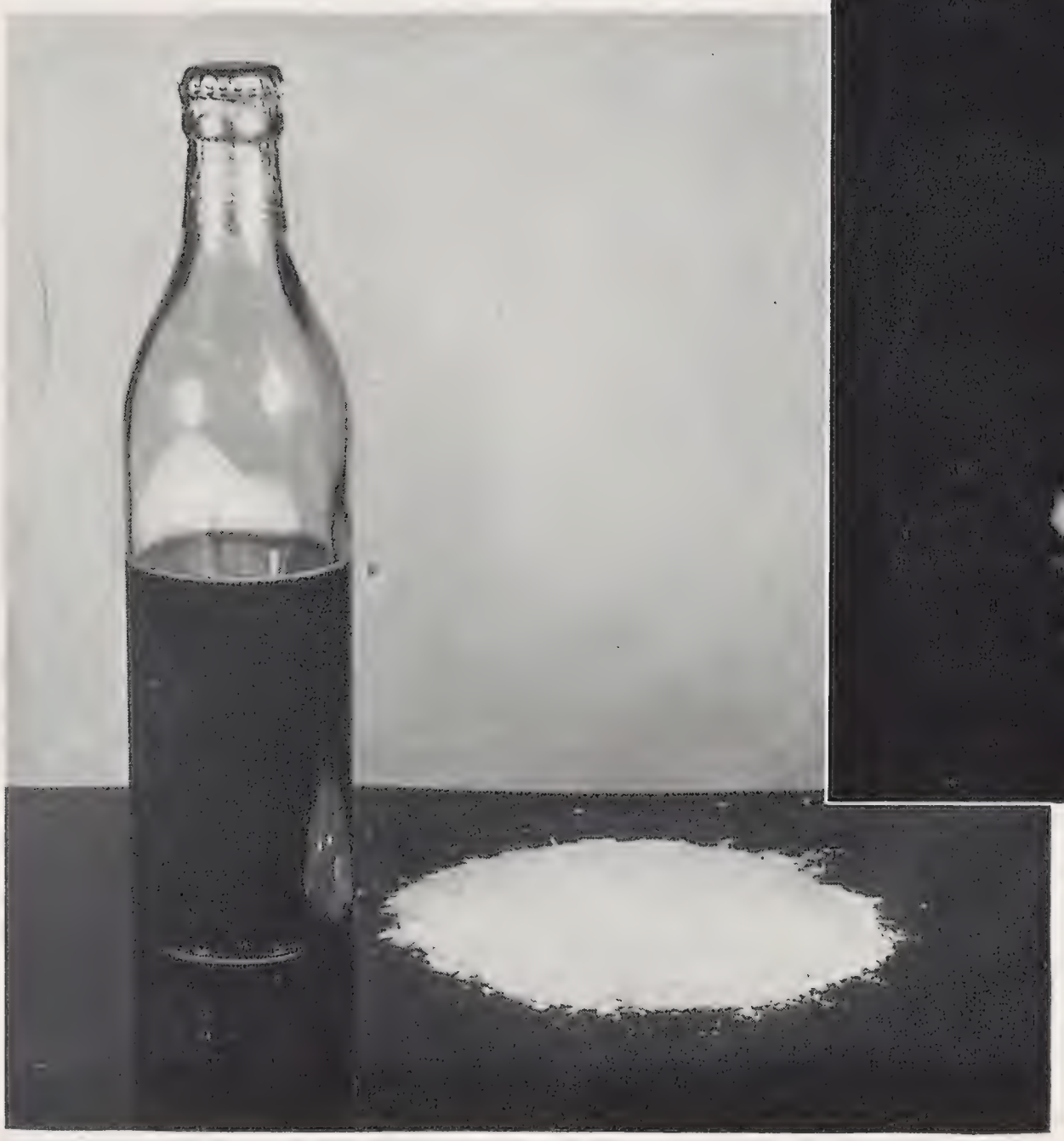
My body cramped from a day of long and intensive activity, my mind completely withdrawn, I am roused by a steady throbbing, and look up to see that the tug is headed homewards. Far off on the horizon is a tiny black smudge in the sky, and I realize that there is another world than this of the ocean deeps—that on the great liner on the horizon people are playing bridge, gossiping, looking at the water with unseeing eyes, while in the dimming light of day the sea dragons beneath their keel are beginning to swim slowly upward on their tigerish quests.



Periphyllum, a deep-sea jellyfish living in absolute darkness. When brought up into sunlight its color is a rich maroon and turquoise.



A Siphonophore, a drifting colony of animals with gas-float adapted to pressure at a half-mile depth. It has a supporting umbrella around the rim of which are feeding and reproductive individuals.



A bottle before and after being lowered to the depth of a mile or more. The enormous pressure of the water crushed the bottle, and reduced the glass to the mass of white, vitreous powder which appears as a white circular patch in the picture.

The tug churns cityward; I look back over the sea oxydizing in the last gleams of sunset, and to quell any possible sentimentalizing, I prefer to let four lines of Kipling crystallize my thoughts of the deep hidden gorge:

"The wrecks dissolve above us; their dust drops down from afar—
Down to the dark, to the utter dark, where the blind white sea-snakes are.
There is no sound, no echo of sound, in the deserts of the deep,
On the great grey level plains of ooze where the shell-burred cables creep."

* * *

Note—So important has seemed this first inauguration of investigation into the Hudson Gorge that I have considered the work carried on during the last summer as an independent expedition, the Eleventh of the Department of Tropical Research of the New York Zoological Society. Two papers are now in press and will soon appear as numbers of Zoologica; *An Annotated List of the Deep Sea Fish of the Hudson Gorge,* and *A Monograph of the Osteology of a New Species of Haplophryne.* Fifty-five species of deep-sea fish were taken in Stations 113 and 114, of which five are new.

The success of this work carried on from the aft deck of an ordinary tug has led to the institution of the same method of work in Bermuda, where corresponding depths can be reached within a radius of several miles of Nonsuch Island. It is intended in the future to resume deep-sea work in the Gorge, and ultimately to study and report on a comprehensive collection of these fish, and to place them on exhibit at the American Museum, as representatives of a fauna wholly new to the hundred mile radius of New York City.

In Bermuda plans are being made to experiment with pressure tanks in an ice cold and black environment, in the hope of being able to keep some of the strange fish of the deeps alive for hours or days. If this is successful, it will be possible in time to come, to bring the specimens taken in the Gorge to New York City and our Aquarium, for exhibition while still alive and glowing.

The photographs accompanying this article are all of organisms secured on the Zoological Society's Expedition to the Hudson Gorge.

Rearing and Photographing Fishes

The interesting experiments of an amateur fish culturist, and some of his photographs.

J. Stuart McLees

OF recent years the literature of Ichthyology has acquired decided interest and some additional degree of accuracy by the use of illustrations reproduced from photographs. Most persons, scientific or otherwise are naturally attracted by reasonably good pictures, and in response to this popular appreciation the art of book illustration has made wonderful advances, based largely on photography and the printing processes made possible by it. Recent work of this kind leaves nothing to be desired from the standpoints of beauty or accuracy, and the field is being rapidly covered by photographers who are attached to all the major scientific institutions.

The writer has experimented in the difficult field of fish photography for his own amusement and the edification of his friends and for this purpose, as well as to gratify his interest in their habits and his pleasure in their grace and beauty, he maintains in a number of small tanks such members of the local fish fauna as are able to withstand the change to domesticated conditions. Returning from a recent visit to the local fish hatcheries with a number of eggs of several species of trout, the thought occurred that here was a corner of the field as yet hardly touched by the new methods; a corner, moreover, that, if it lacked the opportunity for highly artistic and spectacular results, nevertheless had considerable interest and scientific value.

The first problem presenting itself for consideration was the care of the eggs. These require running water of uniform low temperature, and as no special tank was available for their reception they required to be protected from the other occupants, some of which surely would regard such dainty morsels as a very desirable change of diet. Trays therefore were made, patterned after those in use by fish hatcheries, of wooden strips one-half inch by one





Eggs of the lake herring, *Argyrosomus artedi* ready to hatch; *Lower*: newly hatched fry.
Both photographs greatly enlarged.

inch, with a bottom of ordinary mosquito netting. Placed in the tank these sank until they held about half an inch of water and they served very well to protect the eggs, but, as we shall see, they had to be modified when the fry appeared. The tank was already supplied with pure running water and the temperature was found to vary by slow changes between 46 degrees and 52 degrees Fahr.; which variation falls within the permissible limits as is indicated by the successful hatching and rearing of the fry.

Hatching began late in February and new fry continued to appear daily for about three weeks. Attracted by the movement of the fry some of the larger fishes contained in the tank stationed themselves beneath and in their efforts to seize them bumped the bottoms of the trays. The disturbance caused the fry to answer to their instinctive desire to burrow, thus getting their heads between the meshes of the mosquito netting, where they literally lost their heads. The principal offender was a six-inch bluegill (*Lepomis pallidus*) who sometimes was able to pull the whole of the little fish through the mesh. Sheet zinc, perforated with very small holes, was substituted for the netting and the loss from this source stopped at once.

For photography of this kind the writer uses a five by seven view camera, equipped with an f. 8 Velostigmat rapid rectilinear lens of eight-inch focus with shutter working at various speeds from 1/2 second to 1/100 part of a second. A second lens, a five-inch anastigmat, f. 6. 3. in a similar shutter, can be used in place of the "Velostigmat" when somewhat larger magnifications are desired. Any equipment having a long bellows-draw and a focusing device will give good results, but for subsequent enlargement the crystal sharp image given by the anastigmat lens is to be preferred. Printed on a glossy bromide paper all the delicate detail is retained.

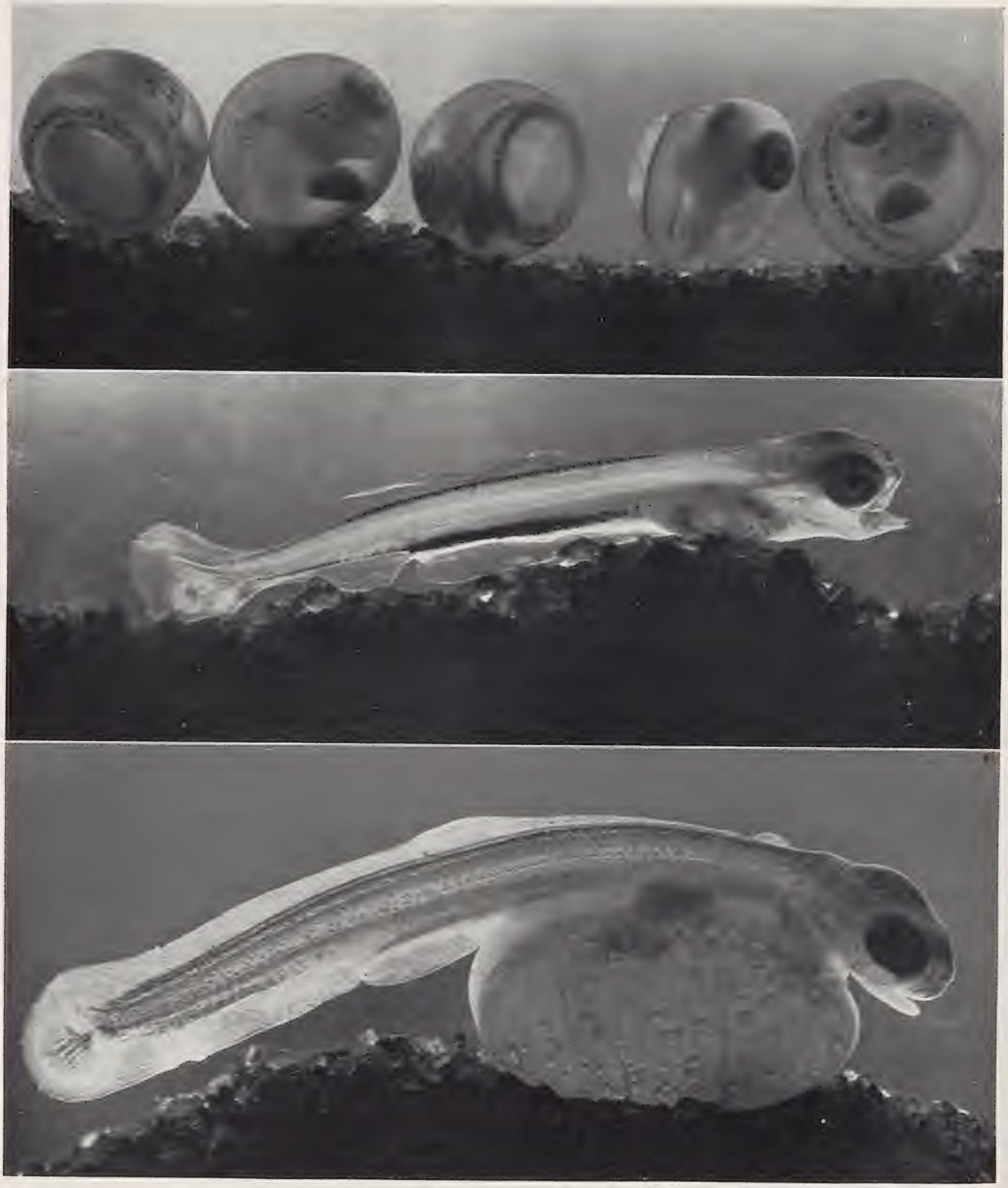
To hold the eggs or fry within a very short focal range and to permit of photography by transmitted light a special cell of plate glass was made, previous attempts to photograph the subjects in glasses, bottles, etc., having resulted in distorted images of various kinds. The cell consisted of five pieces of one-quarter-inch glass cemented together with the household cement used to repair broken china and glassware. Two pieces, each five by three inches, formed the front and back, one piece, one by five inches, became the bottom, and two pieces, each one by two inches, made the sides. A clear central space, the thickness of the glass, was left, and a little coarse sand or fine pebbles placed in this before the eggs or fry were introduced gave a suggestion of natural foreground and saved the necessity of including the harsh line made by the cemented glass.

There are two sources of trouble to be watched if success is to be had: The first is due to the presence of air in the water contained in the glass cell; when placed in the sunshine the water rapidly rises in temperature and this air is deposited in tiny bubbles on the surface of the glass. The other is due to the presence of tiny particles of dirt in the water; when working by transmitted light the bubbles and the dirt give noticeable images which become very prominent when enlarged.

The accompanying photographs were all made by daylight in the sunshine streaming through a south window. With the shutter opening one inch in diameter and the camera extended eighteen inches, i.e., at f. 18, exposures from 1/10 second to 1/50 second were found to be approximately correct but for the sake of greater depth of focus it was often found desirable to stop down to f. 64, with proportionate increase of exposure.

Predatory Animal Survey

At the spring meeting of the Board of Managers held in the Zoological Park on May 16, Mr. A. Brazier Howell, Corresponding Secretary of the American Society of Mammalogists, was designated a representative of the Society in his contemplated study of the conditions affecting the destruction of predatory animals in the West. By resolution the Board authorized the contribution of $250 toward Mr. Howell's expenses in making the preliminary study of this important conservation matter. W. R. B.



Whitefish, *Coregonus clupeiformis;* eggs ready to hatch; *Center*: Whitefish fry forty-eight hours after hatching; *Lower*: Lake trout, *Cristivomer namaycush,* fry, forty-eight hours after hatching. All photographs greatly enlarged.

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BULLETIN

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Upper: Copperhead snake *Agkistrodon mokasen.*
Lower: Timber rattlesnake *Crotalus horridus.*

These species and the massasauga (a small rattlesnake) are the only poisonous serpents of the northeastern States.

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

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Serpents of the Eastern States

The venomous and non-venomous Snakes of the North Atlantic and New England States with descriptions of the various species.

RAYMOND L. DITMARS

Curator of Mammals and Reptiles

Illustrated with photographs made in the Zoological Park by the Author and E. R. Osterndorff and a color plate from a drawing by Helen Tee-Van

MORE than two and one-half million visitors come to the Zoological Park each year. We also answer a heavy correspondence, which is largely in the form of queries about animal life. Frequent queries from visitors, and in letters, indicate the need of a simply prepared, although complete explanation concerning the kinds of serpents to be found in the northeastern area of the United States. This should clearly explain how to distinguish the poisonous from the non-poisonous species, and point out those, among the latter, which are of distinct economic value. It should also describe something of characteristic habits, and show the kind of terrain frequented by various species. All of these points were considered in developing this article.

The array of serpent life in the area covered is rather imposing. There are twenty-one distinct species. Of this number, however, only three are poisonous or in any way dangerous. These are the timber rattlesnake, the massasauga and the copperhead. As both of the former are rattlesnakes and positively characteristic in possessing the warning appendage on the tail, it may simplify the definition of the poisonous reptiles of our northeast to point to two *kinds* of snakes, the rattlesnake and the copperhead.

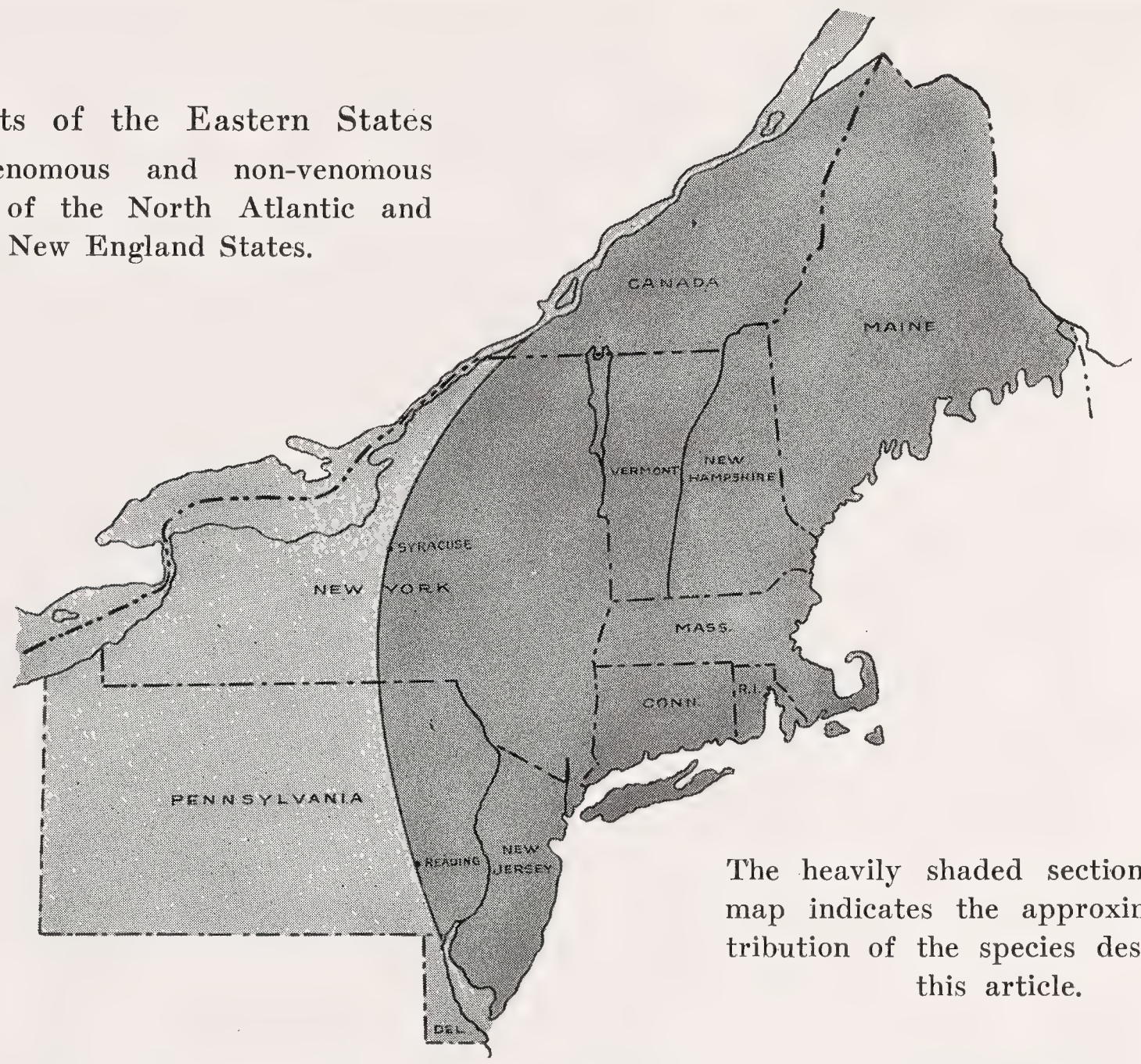
In extensive scientific works for the precise identification of serpents, there are many species, which, on superficial examination appear similar. In such works, definition is through technical differences of head scalation, number of rows of scales around the body, the number of abdominal shields, and relative size and arrangement of the teeth. Coloration and pattern have a part in such descriptions, but as unrelated species may be similarly marked, extremely detailed descriptions are necessary to separate them.

Fortunately this is not the case with our local serpents. The number of species is so moderate and differences so marked, that simple outlines will plainly define each species. No scientific study is necessary in making immediate identification of these local snakes.

The terrain inhabited by the twenty-one species is varied. Some are more commonly found in wild meadows, others rather persistently frequent the immediate course of brooks, small rivers or the margins of ponds and lakes. Some wander rather widely over varying ranges and may be seen almost anywhere on low or high ground. One species shows a marked preference for the arid, sandy stretches immediately back

Serpents of the Eastern States

The venomous and non-venomous Snakes of the North Atlantic and New England States.



The heavily shaded section of this map indicates the approximate distribution of the species described in this article.

of ocean beaches, another for the pine areas of New Jersey and to the southward. The prevailing type of rattlesnake is far more commonly associated with the vicinity or the actual slopes of the mountainous areas, and this condition, though to a lesser degree, is indicated for the more generally distributed copperhead snake.

A key for the identification of the northeastern serpents may be based upon four simple points. These relate to (1) the kind of scales—whether smooth or keeled, (2) the pattern and coloration, (3) size, and (4) shape of the pupil of the eye. This latter character, alone, immediately separates the poisonous species on gross examination. The scales of serpents are either quite smooth, or have a ridge or keel running lengthwise along the center. With some, the keel is faint; with others, like the harmless water snake, garter snake and flat-headed "adder," the keel is very distinct. The local poisonous serpents have strongly keeled scales.

Following is a key to the species, arranged without regard to technical classification, except that the venomous species are in sequence, and conclude the list:

Key to the Species Described

Non-Venomous

1. Pupil of Eye Round
   A—Scales Smooth
   Size—Small
   Brown above; pinkish beneath ..... Worm Snake
   Brown above with minute black dots; yellowish-white beneath ..... Smooth Brown Snake
   Pale green above; white beneath ..... Green Snake
   Dark gray above; a yellow ring around neck; yellow beneath ..... Ring-necked Snake

Size—Moderate

Gray, with chestnut or olive blotches above; square patches of black and white beneath.....MILK SNAKE

Size—Large

Black, with narrow yellow or white chain-like, or narrow cross-ring markings on back; black and white beneath.....KING SNAKE

Satiny black above; black or dark gray beneath; chin and throat white .....BLACKSNAKE

B—Scales of Back Feebly Keeled

Size—Moderate to Large

Grayish or yellow, with vivid, deep crimson blotches along back; black and white beneath. (Distinguished from the similarly marked Milk Snake by its feebly keeled scales.).....CORN SNAKE

Size—Large

Polished black above; beneath white, blotched with gray. Some scales of the sides show narrow white edges. (Distinguished from the Blacksnake by its feebly keeled scales.).....PILOT BLACKSNAKE

C—Scales Strongly Keeled

Size—Small

Brown above; pink beneath.....DEKAY'S SNAKE

Brown or gray above; bright red beneath.....STORER'S SNAKE

Size—Small to Moderate

Uniform pale green above; yellow beneath.....KEELED GREEN SNAKE

Brown or black above, with vivid yellow stripe on back and a similar stripe on each side on third and fourth rows of scales from underside .....RIBBON SNAKE

Size—Moderate

Brown or black above, with a more or less distinct yellowish stripe on back and a light stripe on each side on second and third rows of scales from underside.....GARTER SNAKE

Brown, with three narrow black stripes on back and a bright yellow stripe on each side. Three dark stripes on abdomen.....QUEEN SNAKE

Size—Moderate to Large

Dark brown or blackish above, with more or less distinct reddish transverse bands; white or yellow beneath, spotted with red.....WATER SNAKE

Brownish, olive or grayish, with rather bold darker transverse markings; broad head, snout upturned and sharp.....FLAT-HEADED "ADDER"; HOG-NOSED SNAKE

Size—Large

White, with strong blackish or brown blotches; abdomen marble white; head conical or pointed.....PINE SNAKE

Venomous

2. Pupil of Eye Elliptical. Scales Keeled.

Size—Moderate to Large

Light chestnut brown or pinkish-gray, with a series of dark-brown transverse bands, narrow on the back and becoming much wider on the sides.....Copperhead Snake

Tail ending in a rattle

Grayish, with a series of dark blotches on the back. Top of head with large, symmetrical shields.....Massasauga

Size—Large

Yellowish or grayish, with dark transverse bands; sometimes dark tan or uniform black. Top of head with small scales.....Timber Rattlesnake

The preceding key, coupled with an examination of the illustrations, should suffice in most instances for identification, but the following detailed descriptions will clarify points of doubt and show the arrangement of the species as they appear in systematic lists, although this is of little import in the present instance, owing to the elimination of large numbers of related species occurring outside of the area under consideration. The scientific names have been brought to date, there having been important changes within past years, affecting both generic, and in several instances, specific names.

Descriptions of the Species

Non-Venomous

The Worm Snake, *Carphophis amoena* (Say), (Figure 1), is a very small species and while fairly abundant in some areas is not often observed owing to its secretive habits. Occurrence is "spotty," the species being common in some districts, yet never found in similar terrain but twenty miles or so distant. Thus it is abundant in northern New Jersey, particularly so in the area immediately back of the Palisades along the Hudson, where it hides under stones, burrows into the ground, or under decaying logs. Its occurrence along the eastern portion of the Hudson River valley is problematical, however. Records indicate that it occurs in a number of areas of New Jersey, but is rare north of Connecticut, probably not going into the northern New England states.

The Worm Snake is characteristic with its smooth, shining and cylindrical body and sharp snout. Above, it is light brown or brownish gray; the underside is a delicate shade of pink. It seldom exceeds a length of eleven inches and is usually smaller.

This little serpent might be confused with Storer's snake and DeKay's snake, both of which are of similar size, and inclined to hide under stones. It may be immediately recognized, however, by its smooth and glossy scales. The other two similarly-colored species have keeled scales, imparting a dull, lusterless surface to the back.

The food of the worm snake consists largely of earthworms and soft-bodied insect larvae. It is an oviparous, or egg-laying species.

General range: Southern New England to Florida; westward to Illinois.

The Ring-Necked Snake, *Diadophis punctatus* (Linne), (Figure 2), is so unique in coloration and pattern that it may be distinguished at a glance. It is small, seldom thicker than a quarter of an inch or five-sixteenths of an inch, its smooth scales are lustrous gray or bluish-black, with a brilliant yellow ring around the neck, immediately behind the head, in vivid contrast to the body coloration. Beneath, the color is orange yellow and there is usually a single row of black spots along the center of

the abdomen. The length of adult specimens is from ten to fifteen inches.

Ring-necked snakes frequent damp woods and may be found under flat stones or burrowing beneath the bark of decaying trees. Numbers of them are sometimes to be found under the top stones of old, broken dams which no longer act as spillways. Distribution is quite general, although the species is more abundant in hilly areas.

The food consists of small salamanders and earthworms. The species is oviparous.

General range: Southern Canada to Florida; westward to Illinois.

The Hog-nosed Snake; Spreading "Adder"; Hissing "Adder," *Heterodon contortrix* (Linne), (Figures 3, 4, 5). This is a very interesting snake. No other species among the local harmless serpents exhibits such marked, characteristic habits. When frightened, it will flatten a considerable portion of the neck, by means of elongated ribs which are spread laterally. The head also becomes broad and flat, is tilted to one side, or slowly waved in threatening fashion, while the reptile exhales the breath in long, sharp, hisses. During these manifestations it presents a sinister appearance. It is quite natural that this harmless species has an evil reputation.

Most of these snakes are slain during their harmless bluffing and have no opportunity to exhibit the final resort to escape the intruder. This is in feigning death. The hissing ceases, the body writhes as though in pain, the neck is arched and the jaw drops open. The reptile then rolls on its back, with the appearance of being dead. However, there is one inconsistent phase in the maneuver. If turned with a stick upon its crawling surface, it returns with agility to the former position. Apparently it is convinced that the only position for a dead serpent is lying on its back.

With proportionately the thickest body of any of the local non-venomous serpents, and a wide, distinct head, this snake is often mistaken for the copperhead, from which it differs in its irregular pattern, sharp, shovel-shaped snout, round pupils, and double row of plates under the tail. Moreover, the copperhead never assumes any air of bravado.

The scales of this species are keeled. A large specimen is three feet long, but the greater number of adults are two to two and one-half feet long. Coloration and markings are extremely variable, but the usual hue is yellowish or brown, with dark brown or black irregular cross-bands. Some specimens have bright shades of yellow or red, the latter color being particularly evident anteriorly. Occasional specimens are entirely black.

This snake is most abundant in sandy areas, and is found in considerable numbers in some portions of Long Island, immediately back of the sea beach. It is also common in sandy areas in New Jersey. It is by no means confined to sandy regions, however, as it is also found in the mountains, although sparingly. The greater number of uniform black specimens are observed in elevated areas.

Quite recently its specific name was changed to that by which the Copperhead was known—*contortrix*. Its name was formerly *Heterodon platyrhinus,* but Dr. Thomas Barbour, after a careful examination of the later editions of Linné, finds that owing to an error in early nomenclature, confusing two species, the hog-nosed snake was renamed *contortrix,* in the 12th edition, thus rendering that specific name untenable for the copperhead, the specific name of which is now noted in the systematic lists as *mokasen.*

The hog-nosed snake appears to feed largely upon toads and frogs. It is oviparous.

General range: Very extensive. From Massachusetts to Florida; westward in the south to Texas and in the north to Minnesota.

The Green Snake, *Liopeltis vernalis* (Harlan) (Figure 6). An easily identified species of small size, with smooth scales and uniform pale green hue above, whitish beneath. It is a dainty creature, eighteen to twenty-four inches long, and seldom of greater diameter than three-eighths of an inch. Just before shedding the skin, most specimens are of a greenish-gray hue. Its smooth scalation and whitish underside immediately distinguish it from the following species, which also is uniform green above.

The Green Snake is most frequently found in wild meadows. Its occurrence is erratic. It

is common in some portions of the Kittatinny Mountains and the Catskills. There are equally favorable areas, from the viewpoint of topographic conditions, where it is seldom seen. Its occurrence is thus "spotty" in the whole northeastern area.

This is one of the few insectivorous serpents. It feeds largely upon soft-bodied insect larvae, crickets, grasshoppers and spiders. It is oviparous, depositing elongate, soft eggs under flat stones.

General range: Southern Canada to Florida; westward to the central States and in the south to New Mexico.

Keeled Green Snake, *Opheodrys aestivus* (Linne), (Figure 7). Except in New Jersey, this species is rare in the area under consideration. It has been recorded in Connecticut and Pennsylvania, but does not appear to occur in the northerly New England area. It is pale green above and bright yellow beneath, the under hue making it distinct from the other local green snake. A point for instant identification, however, is its keeled scales, imparting a rough appearance, in place of the satiny surface of the common species.

This is essentially a southern species. New Jersey and southern Pennsylvania might be considered as the northerly limit of the normal range. Daniel Carter Beard, council officer of the Boy Scouts of America, has written that he has found the species at Hawley, Pennsylvania, which is north of the latitude of Port Jervis; and a number of years ago, I found several specimens of this snake near Waterbury, Connecticut. They were in a grapevine, which was attached to the side of an old farmhouse. It is a larger species than the smooth green snake, attains a length of about three feet, and is more arboreal in habits.

Feeding is similar to the former species, and it is also oviparous.

General range: Pine barrens of New Jersey, to Florida; westward to southern Illinois and south to New Mexico.

The Blacksnake or Black Racer, *Coluber constrictor* (*Linne*), (Figures 8, 9). This is the largest of the broadly distributed local serpents, with the exception of the somewhat similar mountain or pilot blacksnake. The two species are often confused on gross examination. The black racer is of satiny luster, with smooth scales. It is of uniform black above, both scales and skin. The only break in its monotone is a white patch on the chin or the lower labial plates.

The blacksnake is of interest in being alert, extremely swift, and savage if cornered. Occasional specimens, in the breeding season, which is May, will actually attack. They will glide toward an intruder on the ledgy hibernating quarters, striking madly at one's feet or legs. If among dried leaves, it will vibrate the tail, producing a buzzing sound. This is also the habit of the mountain blacksnake, corn snake, pine snake, king snake, milk snake and the poisonous copperhead.

This serpent is not an enemy of the rattlesnake, nor is it a constrictor, as the scientific name implies. Both species have been noted in close proximity, basking in the sunshine, apparently in entirely normal, fraternal association.

The food consists of frogs, small rodents and small birds—rodents forming the greater portion of the food. It is of economic value, and should be preserved. The eggs are laid under flat stones during June or July, and hatch in from six to eight weeks' time. They are unique among the eggs of the local, oviparous serpents, in appearing as if sparsely sprinkled with grains of coarse salt. The young are grayish and strongly blotched when hatched, and retain this pattern up to the following summer, somewhat resembling young milk snakes, but distinguished by the proportionately large eyes and by the tendency of the blotches on the back to become very narrow as they approach the tail, practically disappearing posteriorly. Adult specimens attain a length of six feet.

General range: The typical black racer inhabits the entire eastern United States, extending westward to the great plains, where it gives way to a paler variety, grayish or bluish, with yellow undersurface, the blue racer of the plains, which extends westward to the Pacific Coast.

The Corn Snake, *Elaphe guttata* (Linne), (Figure 10), is a southern species and seldom is found north of Maryland, but as it has been

recorded several times from the state of New Jersey, comes within the scope of the present listing. Dr. Henry W. Fowler, of the Academy of Natural Sciences of Philadelphia, writes: "Specimens were taken at Chatsworth, New Jersey . . . and this is the only locality I know it from in the state limits." We received a small adult specimen which had been picked up by an automobile party in what was described as the central part of the pine barrens, probably not far from where Dr. Fowler recorded it.

Coloration and pattern are very striking. The ground hue is gray, tan or reddish. On the back is a series of large, crimson saddles, narrowly bordered with black. There is a series of similar blotches, though smaller, on the sides. The abdomen is white, with large black squares. The pattern is rather similar to that of the milk snake, but the corn snake has faintly keeled scales. In its southerly range it attains a length of six feet. The name of corn snake is derived from its habit of frequenting fields of ripening grain, where rodents may be plentiful.

Food consists of small rodents and birds. The species is oviparous.

General range: Southern New Jersey to Florida; westward to the Mississippi.

The Mountain Blacksnake or Pilot Blacksnake *Elaphe obsoleta* (Say), (Figure 11). The largest local species, attaining a length of eight feet, and a diameter of two inches. A specimen captured near Forestine, Sullivan County, New York, was eight feet four inches long, and during its struggles to escape, disgorged a full-grown red squirrel. It is a powerful constrictor.

As previously explained, this species is quite similar to the black racer, on gross examination. However, it may be distinguished by the faintly keeled scales, wide head, stouter body, and tendency of the scales to show narrow white edges; also, by a considerable portion of the abdomen being white.

Distribution of this species points to its preference for higher ground. It often climbs into trees, living on heavy horizontal branches which terminate near a sheltering crevice formed by the disintegration of a rotted knot. Specimens were found living in a great tree and sheltering in a hollow area immediately beneath a colony of wild bees. They have been noted in the Kittatinnies, the Hudson Highlands, the Ramapo Mountains and elevated portions of Connecticut. A six-foot specimen was taken on a hill near the reservoir immediately outside the city limits of White Plains, in Westchester County, New York.

The food consists of rodents and birds, apparently never cold-blooded prey. While alleged to commit depredations among small birds, its rodent-destroying habits should be noted. Also, the fact should be remembered that this reptile existed as a part of the natural fauna long before human ideas resulted in lists of so-called "vermin" and "predatory animals" to be destroyed, with the view of improving Nature's original plans. The species is oviparous.

General range: Central Massachusetts to Michigan; southward to Florida and Texas.

The Pine Snake, *Pituophis melanoleucus* (Daudin), (Figure 12), occurs only in the southerly pine barren regions of New Jersey, and southward. It is fairly common in the New Jersey area.

This is one of the largest and heaviest species of serpent in the northeastern states. Specimens six feet in length are not rare. The coloration is intense and rather characteristic. The usual marking is dull white on the back, becoming intensely white on the sides. Down the back is a series of large black blotches, closer together and not sharply defined on the forward portion, but posteriorly wider apart and in vivid contrast. The greater portion of the abdomen is marble white. The head resembles that of a turtle, being proportionately small and the sharply pointed snout protrudes over the lower jaw.

When annoyed, the pine snake takes a deep breath, opens the mouth slightly, and by means of a small, voluntarily erectile appendage in front of the breathing passage or glottis, is able to eject the air with a loud, hissing sound. It is a constrictor.

Food consists of rodents and birds. It is oviparous.

General range: The pine barrens of southern New Jersey, to Florida.

The King Snake, *Lampropeltis getulus* (Linne), (Figure 14). Like the pine snake, corn snake and the keeled green snake, this is a southern reptile, barely extending its range into the area of this list. Its status is rather like that of the corn snake, though possibly more king snakes have been noted in New Jersey. Dr. Fowler, who prepared a list of amphibians and reptiles of New Jersey, explains: "The King Snake is known to me only from the region of the coastal plain of New Jersey."

Northern specimens are seldom longer than four feet. The scales are smooth and lustrous, and the average specimen is black with narrow yellow or white cross-bands, which fork on the sides and connect in chain-like fashion. The abdomen is black with large patches of white or yellow.

A decided tendency toward cannibalism renders this species unique. It attacks and kills other snakes of dimensions closely approaching its own, and kills and devours copperhead snakes and rattlesnakes. It is immune to the bites of poisonous species. Rodents form a considerable part of its food and the species may be regarded as of definite economic value. It is particularly docile and quickly tamed. Like all of the preceding species, it is oviparous.

General range: New Jersey to Florida; westward to the Mississippi Valley.

The Milk Snake or Checkered "Adder," *Lampropeltis triangulum* (Lacepede), (Figure 13). Consideration of this species brings us to a reptile inhabiting the greater part of the northeastern area. It is brightly marked, of fair size, and the numerous specimens sent to us for identification indicate that it is often mistaken for the copperhead, from which it may be immediately distinguished by the smooth scales. Although generally distributed, it is not usually common.

Coloration is yellowish brown or gray, with a series of irregular, chestnut-brown or reddish blotches, edged with black. On some specimens these blotches are dark olive. On the sides are smaller blotches in alternation with those on the back. It is white beneath, with small oblong spots of black.

It has acquired the name of "milk snake" from its habit of prowling into stables, where it is alleged to steal milk from the cows. This is rather a ridiculous theory and proof of the deed from careful observers is wanting. Captive specimens are quite indifferent to milk. As the species feeds largely upon small rodents, its presence in stables and barns may be accounted for as a search for mice and young rats. It is a constrictor, and oviparous, laying twenty or more eggs with soft, leathery shell. Young specimens are marked like the parent but are of more vivid coloration.

General range: Massachusetts to North Carolina; westward to Illinois and Wisconsin. Varieties, with brighter red markings, extend southward to the Gulf of Mexico and southwestward nearly to the Pacific Coast.

The Striped Water Snake; Queen Snake, *Natrix septemvittata* (Say), (Figure 15). When young, this species looks somewhat like a dark garter snake without a dorsal stripe, but retaining yellow stripes on each side. It is readily separated from that species by three pronounced, dark stripes extending along the abdomen. It is a small and rather slender snake, usually two feet in length, or slightly longer. Adults are dark brown, with three narrow black stripes on the back, which may be indistinct. The bright yellow stripe on the lower portion of the side covers one-half of the first and second rows of scales.

This is a persistently aquatic reptile, sometimes hanging on the bushes above brooks or small streams of rather rapid motion. In the area outlined in this work, the Striped Water Snake appears to avoid sluggish streams and ponds.

Food consists of frogs and toads. The species is viviparous, bringing forth the young alive.

General range: Western Pennsylvania to Wisconsin; southward to the Gulf.

The Water Snake, *Natrix sipedon* (Linne), (Fig. 16, 17). This persistently aquatic serpent, seen along ponds and streams, should not be called a "moccasin." That term properly designates a poisonous water snake of the South, and is also applied in some southern areas to the copperhead, where the latter is referred to as the highland moccasin.

Our local water snake, member of a genus represented by about a dozen semi-aquatic species, in south-central and southern areas, is an ugly looking reptile and savage when restrained. However, it is in no way related to the poisonous moccasin or "cotton mouth" snake. The northerly limit of the latter is southern Virginia.

The body of the water snake is rather stout, with strongly keeled scales; the color is brown, with broad, irregular cross-bands of reddish brown, which show more plainly on the sides. The abdomen is yellowish white, usually brightly marked with red spots and blotches. Large or old specimens may appear a uniform dull brown or almost black. The young are quite different from the adult, being gray, with the cross-bands blackish and very distinct. Large adults are four feet long and fully two inches in diameter. The average size is two and one-half to three feet in length.

While there are allegations about the water snake being harmful in destroying game fish, this is not at all likely. The game fish, as a rule, are too active for the snake to catch them. It pursues the slower-moving fish, as well as frogs and toads. Frequenting the margins of ponds and lakes, large and small streams, old dams or the stone bases of roughly-constructed bridges, the water snake may often be seen basking on a rock, stretched on the bank or even on branches overhanging the water, into which it plunges when alarmed. This is the second species so far considered which is viviparous. The young are produced alive, and as many as three dozen or more in a litter. They are born during late August or early September.

General range: Northern and northeastern United States.

De Kay's Snake or Brown Snake, *Storeria dekayi* (Holbrook), (Figure 18). There should be little difficulty in identifying this, and the closely allied Storer's or red-bellied snake of the same genus.

The coloration is brown, or brownish gray above, with a minute series of black spots in pairs, these usually present on the back. The central area between these spots is sometimes of a lighter tint than the ground color, imparting, on some specimens, the effect of an indistinct stripe. Beneath, the color is pinkish white. The scales are strongly keeled. The average length of full grown specimens is about one foot.

This snake still occurs in several areas in Central Park, hemmed in on all sides by the congestion and bustle of New York City. There is an old cemetery, less than a city block square, in the Borough of the Bronx, New York City, where these little serpents are fairly abundant. Occurrence in the northeastern states is general, except in elevated areas where this species appears to be replaced by the allied Storer's snake.

The Brown Snake is frequently found hiding under flat stones. In such places it can find its food which consists largely of earthworms, and is unique in surviving in localities where other serpents, even the common garter snake, have long disappeared. Its secretive habits, diminutive size and dull coloration aid in its protection. It is a viviparous species. The young are very dark, with a whitish ring around the neck, and resemble the young of the ring-necked snake, but may be distinguished by their keeled scales.

General range: Southern Canada and eastern United States; southward to Mexico.

Storer's Snake; Red-bellied Snake, *Storeria occipito-maculata* (Storer), (Fig. 19, 20). Similar in form and upper coloration to the preceding, although many specimens are a bit smaller. It may be distinguished by the vivid, vermilion undersurface. There is a tendency to have a paler band on the back. Some specimens are a rich brown and others slaty gray. The gray specimens usually have the strongest defined dorsal band, which is intensified by being bordered with rows of minute black spots. The average length is eight to ten inches.

This is a species of the more elevated and wilder areas, and does not occur in the immediate vicinity of New York City. Together with the ring-necked snake, it occurs in portions of New England where the winters are very severe and other serpents (except the striped snake) are rare or entirely absent.

Food consists mainly of earthworms. The species is viviparous and the young are black, with whitish ring around the neck.



Fig. 1. Worm Snake, *Carphophis amoena*. A burrowing species which is rather common, but seldom observed. It is brown, with smooth and polished, almost opalescent scales. The food consists of earthworms and insect larvae.

Fig. 2. (*Lower*) Ring-Necked Snake, *Diadophis punctatus*. This species is unique in coloration. The smooth and satiny scales are lustrous gray and in contrast to this coloration there is a brilliant yellow ring around the neck. It is secretive, and lurks under flat stones or old fallen tree trunks.

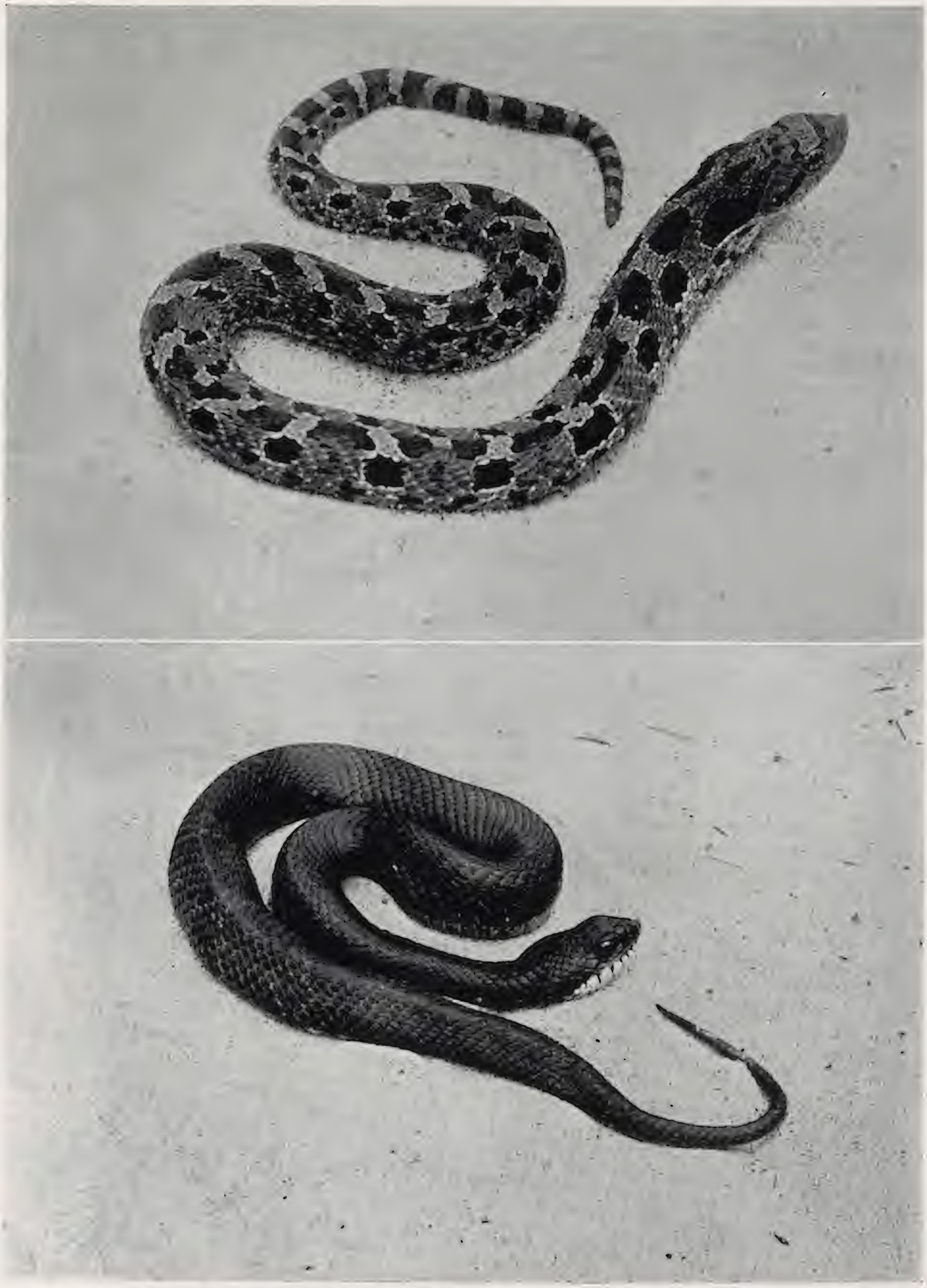


Fig. 4. Hog-nosed Snake; Spreading "Adder," Hissing "Adder," *Heterodon contortrix*. Characteristic among the local serpents in its ability to flatten the head and neck to wide extent and emit sharp hisses. If further alarmed, it rolls upon its back and feigns death. It seldom attemps to bite.

Fig. 5. (*Lower*) Black Hog-nosed Snake. A dark variation of the species figured above. The typical form is more frequent in sandy places, while black specimens frequent elevated areas.



Fig. 3 Hog-nosed Snake; Spreading "Adder." *Heterodon contortrix.* Some snakes lay eggs and others produce living young. The former are designated as oviparous and the latter as viviparous; or, to be technically exact, ovo-viviparous, meaning that the eggs are retained within the oviduct until the young are fully developed. The oviparous species bury their eggs in soil or under flat stones, where they hatch, without parental care, in about six weeks' time.

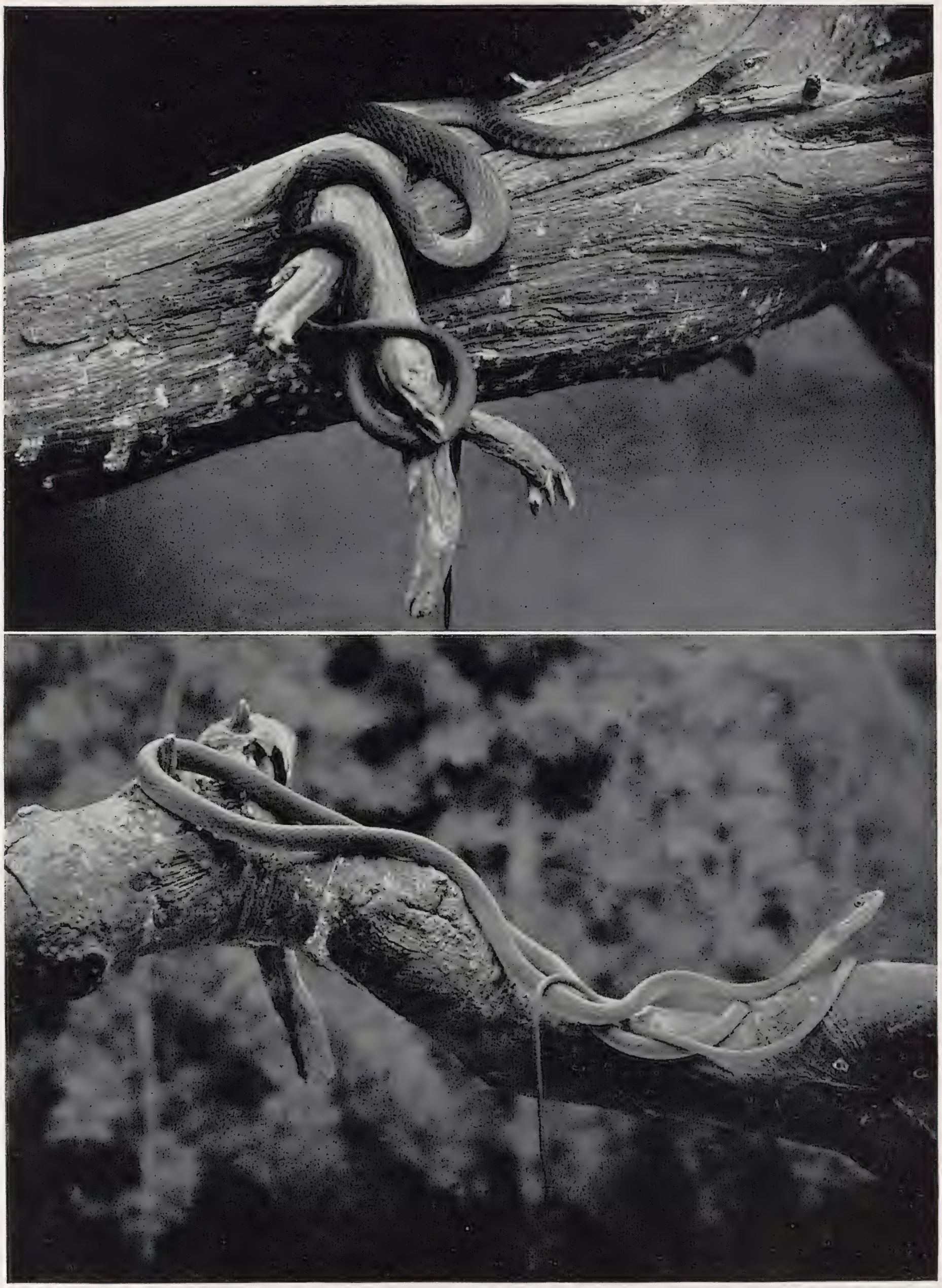


Fig. 6. Green Snake, *Liopeltis vernalis*. Occurs in wild meadows, but is not frequently seen, owing to its protective coloration. The scales are of satiny luster and leaf green in color.

Fig. 7. (*Lower*) Keeled Green Snake, *Opheodrys aestivus*. While similar in coloration to the species figured above, there is a marked difference in the texture of the scales. With this species they are keeled, each showing a raised line or ridge running lengthwise along the center. Both of the green snakes feed upon insects.

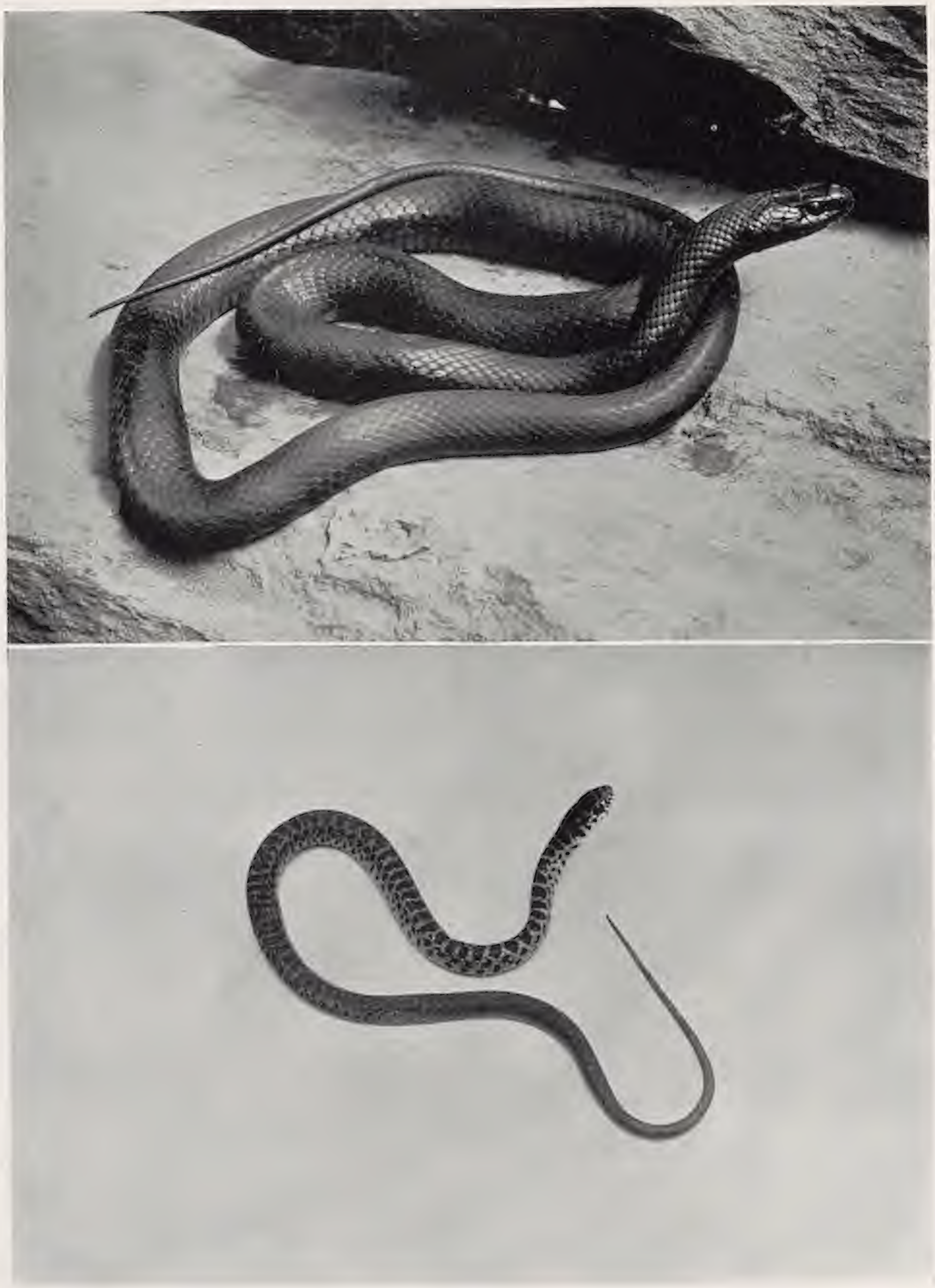


Fig. 8. Blacksnake; Racer, *Coluber constrictor*. This and the pilot blacksnake are the largest of the broadly distributed local serpents. The scales are smooth and satiny, distinguishing the species from the other blacksnake, with which it is often confused. The racer is a useful reptile as it feeds largely upon rodents.

Fig. 9. (*Lower*) Young of the common Blacksnake. The eggs are laid early in July and may take nearly two months to develop. The young are spotted until late the following year.

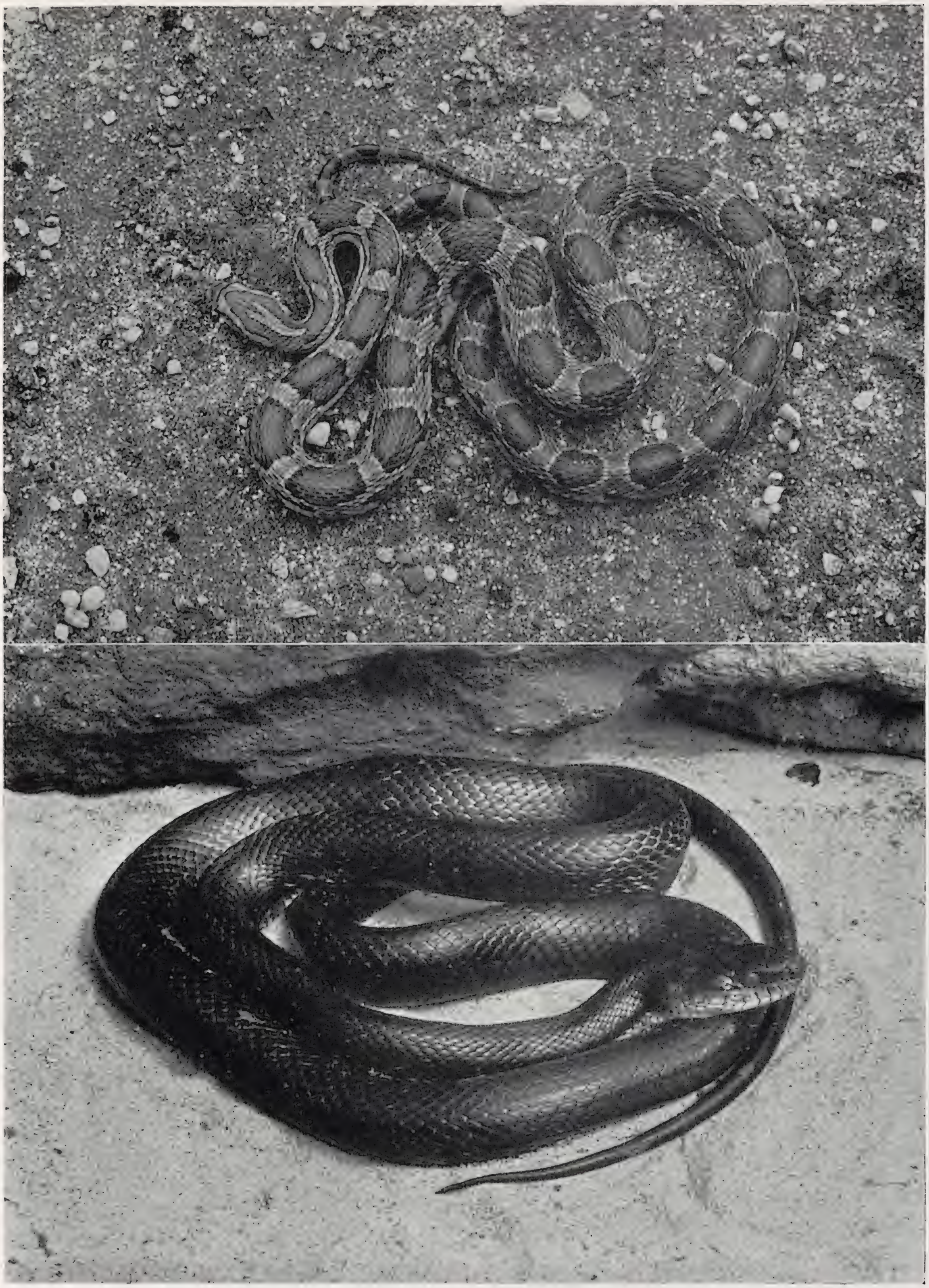


Fig. 10. Corn Snake, *Elaphe guttata.* A southern species, extending northward only into southerly New Jersey. Coloration and pattern are striking, the back being grayish or tan, with large crimson blotches.

Fig. 11. (*Lower*) Mountain Blacksnake; Pilot Blacksnake, *Elaphe obsoleta.* Largest of the local species. It attains a length of eight feet. Occurence is largely confined to the more elevated areas. This serpent is frequently confused with the common blacksnake, but may be distinguished by its faintly keeled scales, many of them narrowly edged with white.

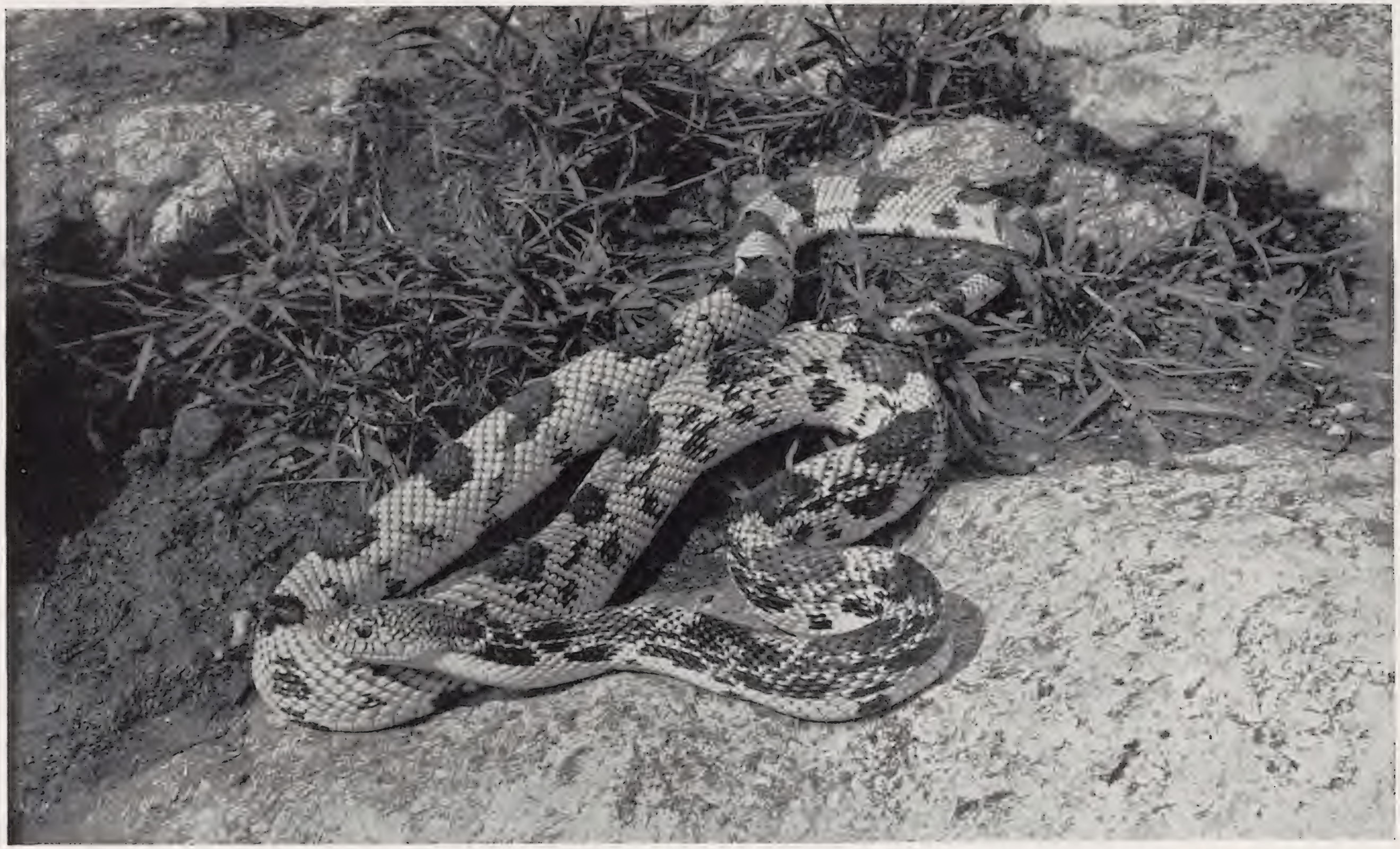


Fig. 12. Pine Snake, *Pituophis melanoleucus*. In the local area, the distribution extends only into the pine barren regions of New Jersey, where this large species is fairly common. The habitat extends southward to Florida. This powerful species is one of the largest serpents of the East, and is characteristic in taking deep breaths when annoyed, opening the mouth slightly, and producing a loud, hissing sound by expelling the air against an erectile appendage in the lower jaw.

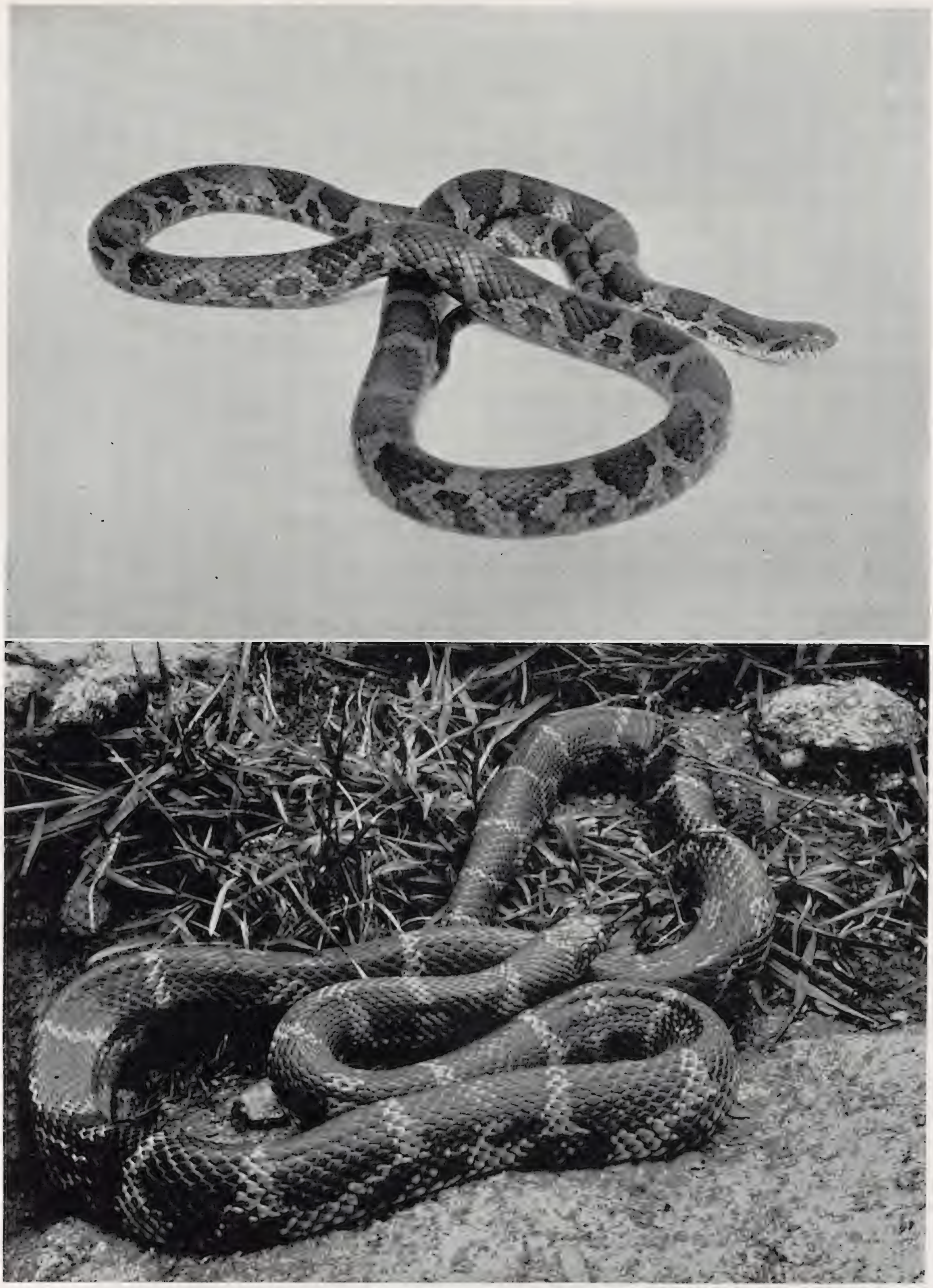


Fig. 13. Milk Snake, *Lampropeltis triangulum*. Of economic value, yet branded by a common myth alleging that it lurks around barns to steal milk from the cows. It frequents old buildings in search of small rodents, upon which it feeds. The brown blotches also result in specimens being mistaken for copperheads.

Fig. 14. (*Lower*) King Snake, *Lampropeltis getulus*. A southern species, ranging into central New Jersey. It is immune to the poison of venomous snakes and will constrict and eat well-grown copperheads and rattlesnakes.



Fig. 15. Striped Water Snake, *Natrix septemvittata*. The range of this species extends but slightly into the westerly portion of the local area covered in this article. When young, this species looks somewhat like a dark garter snake without a dorsal stripe. Adults are dark brown with three rather obscure dark stripes on the back. Brooks and rather swift streams are the usual lurking places, where specimens sometimes may be seen in bushes overhanging the water.



Fig. 16. Water Snake, *Natrix sipedon*. This is the common brown water snake, which is broadly distributed and so frequently seen along the margins of ponds and brooks, near the crevices of foundations of old bridges, or lurking among the flat stones of disintegrated dams. It is improperly called "water moccasin," a name confusing it with a poisonous water snake of the southern states. There is no poisonous water snake in the Northeast.

Fig. 17. (*Lower*) Young Water Snake, showing distinct markings. Old specimens are usually dull brown above.

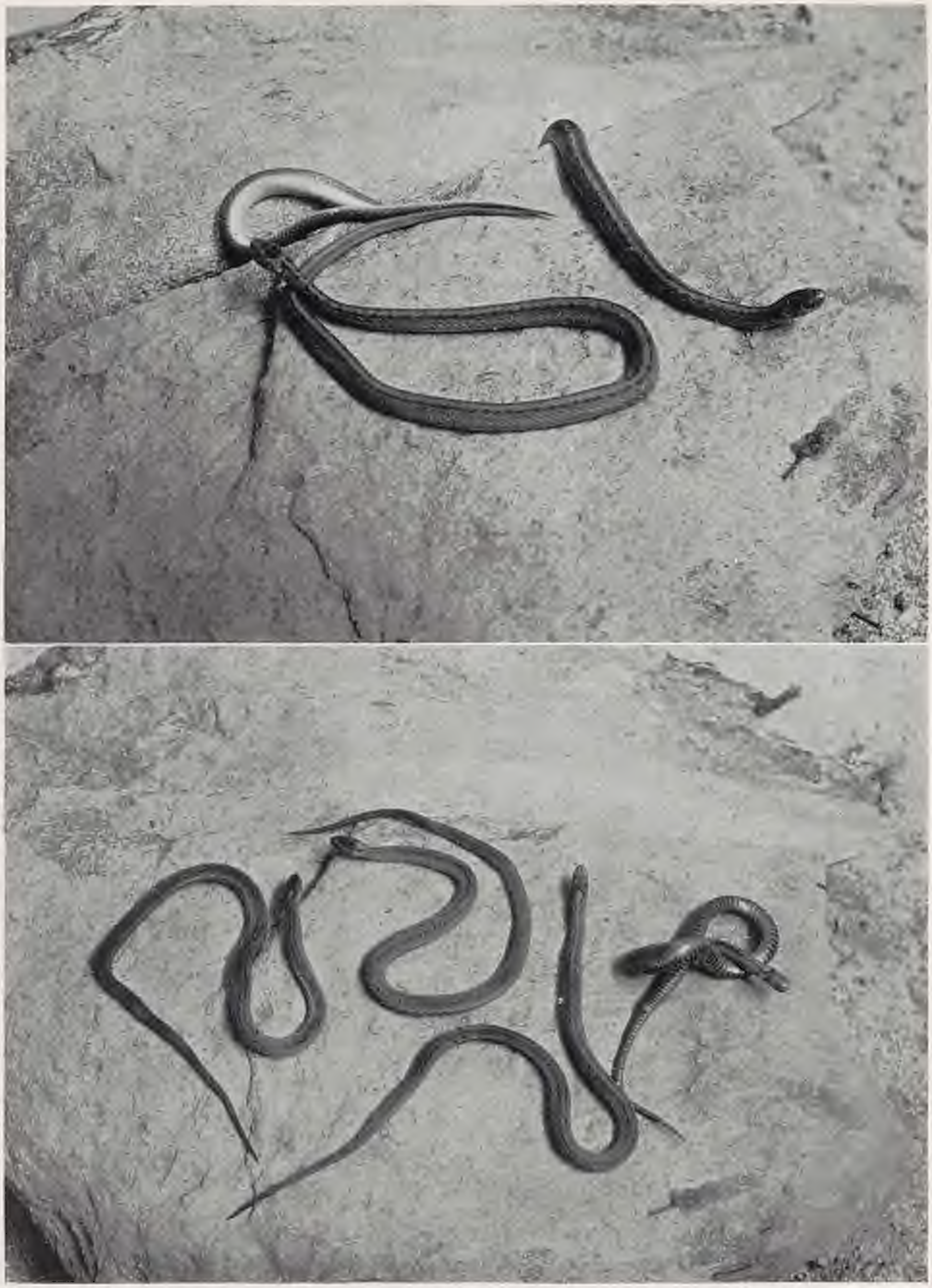


Fig. 18. De Kay's Snake; Brown Snake, *Storeria dekayi*. Seldom over one-quarter of an inch diameter, dull brown in colors and because of its habit of hiding under flat stones, this unobtrusive little serpent has survived in areas where other snakes have long since disappeared.

Fig. 19. (*Lower*) Storer's Snake; Red-bellied Snake, *Storeria occipitomaculata*. Similar in form and upper coloration to the species figured above, but distinguished by the brilliant red under-surface. The distribution is largely confined to the more elevated areas. Several color phases are shown. The upper central figure is a slaty gray specimen from the Catskills.

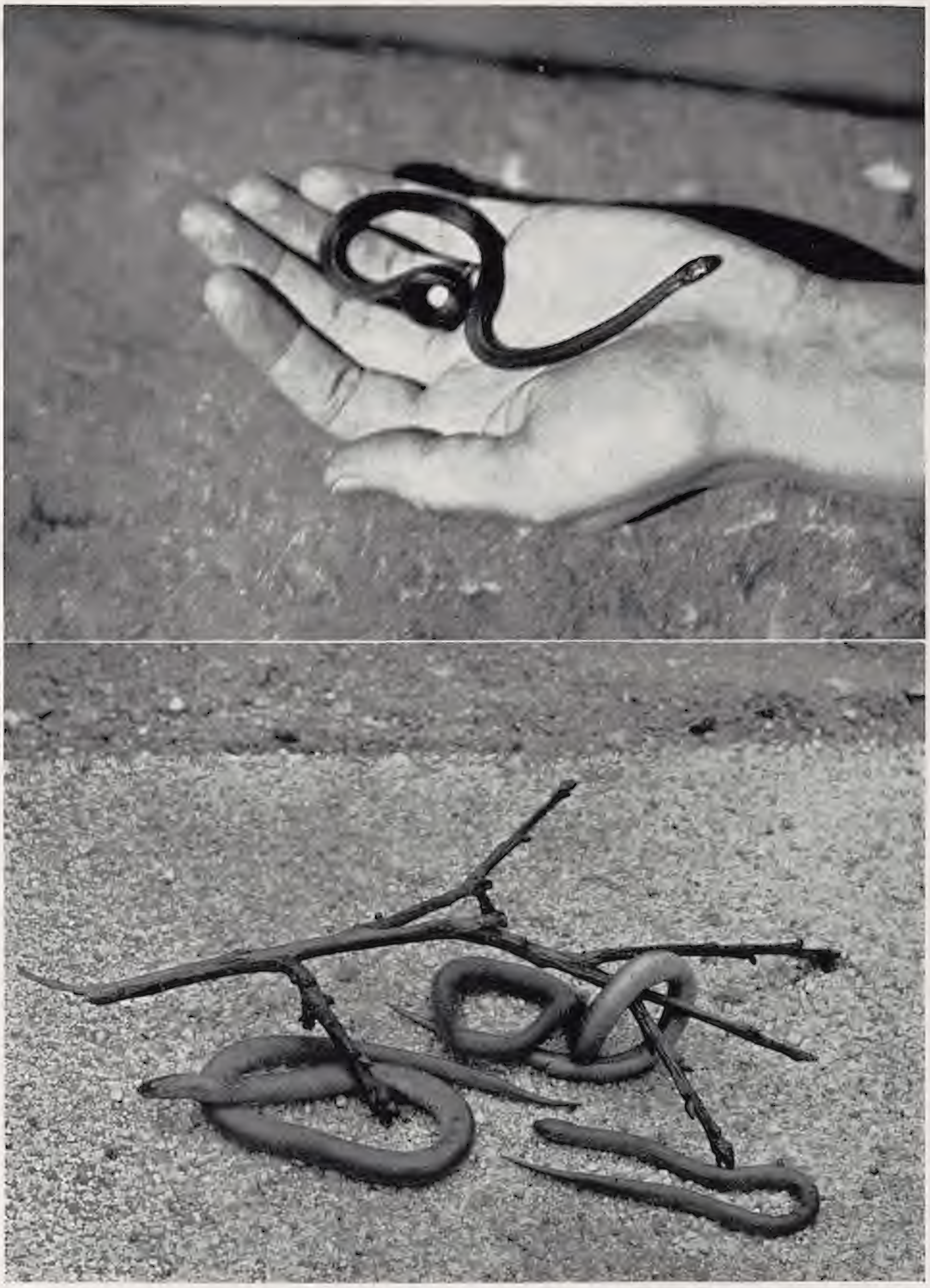


Fig. 20. Storer's Snake; Red-Bellied Snake. Indicating the dimensions of an adult specimen from Sullivan County, New York. The food of the three species of little brown snakes (including the species shown below) consists largely of earthworms, although the young are so diminutive they search for the soft-bodied larvae of small insects.

Fig. 21. (*Lower*) Smooth Brown Snake, *Virginia valeriae*... Ranges only into the extreme southerly area of the northeastern states. Immediately distinguished from the other brown snakes by its smooth scales.



Fig. 22. Ribbon Snake, *Thamnophis sauritus*. Two closely related striped snakes occur within the local area. Their general characteristics are clearly shown in the cuts on this page. The Ribbon Snake is considerably more slender and its side stripes are higher up on the sides than those of the commoner Garter Snake.

Fig. 23. (*Lower*) Garter Snake, *Thamnophis sirtalis*. Most abundant and generally distributed of any of the local species. A large specimen is about three feet in length. The central stripe is indistinct on occasional specimens.

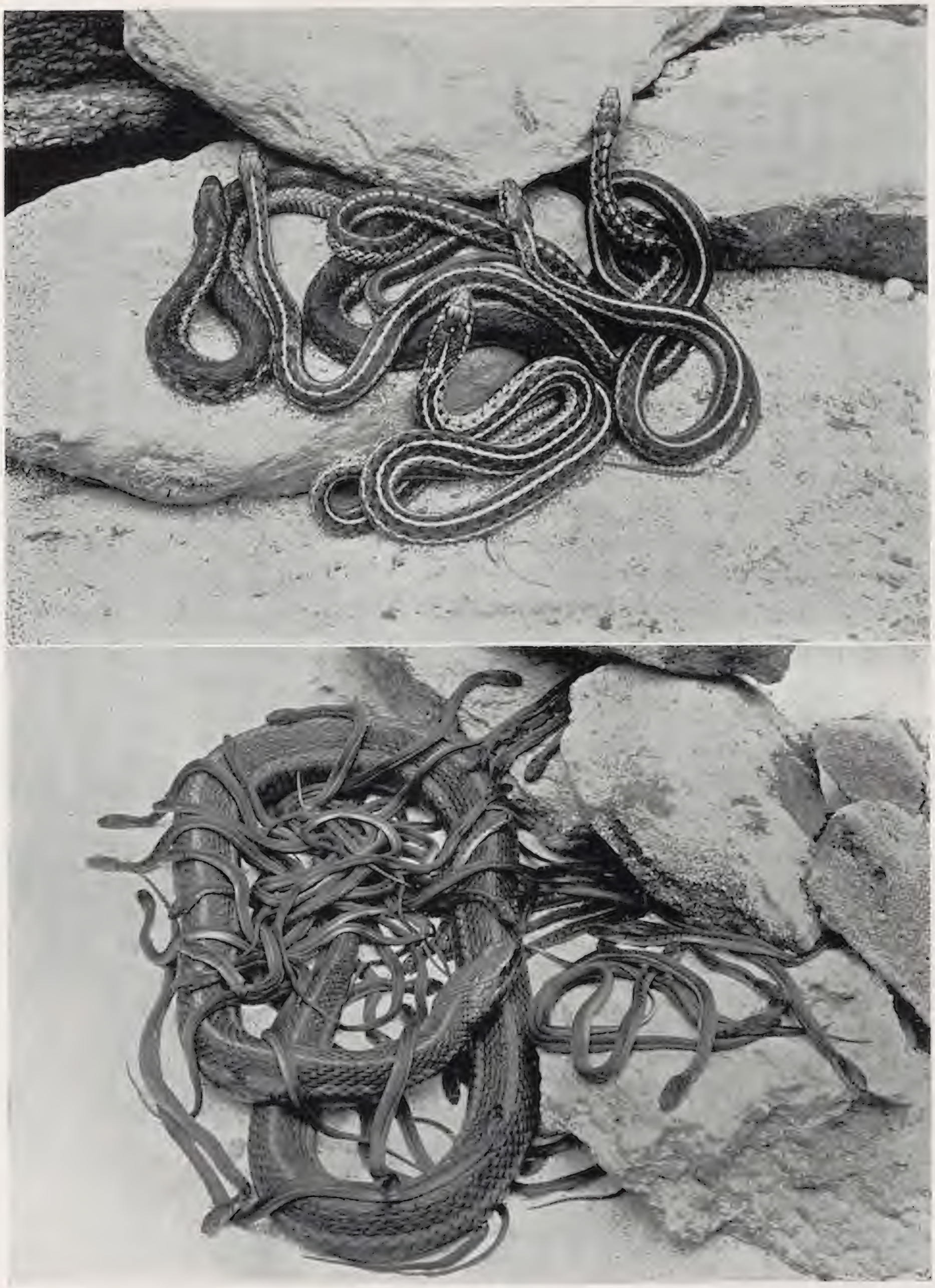


Fig. 24. Varieties of the Garter Snake, *Thamnophis sirtalis*. The specimen at the left is from the Kittatinny Mountains, and the central or dorsal stripe is lacking.

Fig. 25. (*Lower*) Garter Snake and young. The presence of the young near a viviparous parent does not indicate parental care. The young reptiles are immediately ready to shift for themselves when born, although they may incidentally remain near a crevice where the mother is sunning. Litters of garter snakes and water snakes vary from a dozen to over fifty.

General range: Similar to the allied, preceding species, but extends farther north into Canada.

The Smooth Brown Snake, *Virginia valeriae* Baird and Girard, (Figure 21). Owing to its smooth scales and small size, there is a possibility of confusing this species with the Worm Snake, (*Carphophis*) but it ranges only into the extreme southerly area of this list—southern New Jersey.

Its snout is not so sharp as that of the Worm Snake, and the scales are of rather satiny luster. The color is dark chestnut or grayish-brown, usually with two rows of minute black dots on the back. The abdomen is yellowish-white. Average length is between six and eight inches.

The Smooth Brown Snake feeds on worms and soft-bodied insect larvae and is viviparous.

General range: Southern New Jersey to Georgia; westward to Tennessee.

The Ribbon Snake, *Thamnophis sauritus* (Linne). (Figure 22). The two striped snakes occurring in the local area may be separated by difference of form, intensity of pattern, and location of the lateral stripe.

The Ribbon Snake is the more slender, and its pattern considerably more intense than the related garter snake. Coloration is dark brown or black, with a bright yellow stripe down the back and a similar stripe on each side, situated on the *third and fourth rows of scales* from the plates of the abdomen.

Distribution is quite general in more or less undisturbed areas, though it is not nearly as abundant as the garter snake. It frequents damp meadows and the grassy borders of brooks and might almost be noted as semi-aquatic. It is a member of a genus with several species as fully aquatic as the water snake. It seldom exceeds a yard in length.

Food consists of small fishes, tadpoles and frogs. It is viviparous, but the litters are small, there seldom being as many as a dozen young.

General range: Southeastern Canada and eastern United States to the Mississippi Valley; southward to Georgia and Alabama.

The Garter Snake or Striped Snake, *Thamnophis sirtalis* (Linne), (Figures 23, 24, 25), is the most commonly seen of the local serpents. Distribution is general and it is fairly abundant near reclaimed or improved areas, where other snakes have long since disappeared. It is common along the salt meadows immediately west of the lower Palisades of the Hudson, and in many of the suburban areas of New Jersey and New York. Large numbers inhabit the old reservoir site along Jerome Avenue, in the northerly part of New York City, and even occur on the northerly portion of Manhattan Island. It is found about everywhere in the rural districts where snakes occur.

The general color is dark brown or black, with three yellowish stripes extending lengthwise. The color beneath is greenish yellow. The skin along the sides, when distended, shows numerous white or pale greenish spots, which are often so arranged that a checkerboard or tessellated appearance is produced when the scales are widely separated after eating, or if the reptile is angry and greatly flattens the body. Coloration and pattern are quite variable. The stripes may be more or less distinct. When the side stripes are present, they are always on the *second and third rows of scales,* counting upward from the abdominal plates. With some specimens, the central stripe may be ragged or broken, and with others from the mountainous areas of New England, the stripe is usually very faint or absent. With these, the tessellated pattern of the skin invades the scale coloration, producing a checkered effect. The side stripes remain to assist in identification.

The Garter Snake feeds only upon cold-blooded prey, such as frogs, toads, tadpoles, salamanders and earthworms. The length of a large female adult is about a yard, while the males are seldom over two to two and one-half feet in length. This is a viviparous species, bringing forth as many as thirty young in a litter. The markings of the young are similar to the parent, although the tendency toward tessellated pattern may be more pronounced.

General range: Probably extending farther north in easterly Canada than any other species of serpent. According to Dr. Thomas Barbour, it ranges up to the 50th degree of latitude. Extends southward through Florida and westward to Minnesota.

Summary

The Local Non-Venomous Serpents

The largest of the local species, and approximately ranking in size in the order named, are the mountain blacksnake, pine snake, common blacksnake or racer, king snake, corn snake, water snake and milk snake.

The most diminutive species are the worm snake, De Kay's snake, Storer's snake and smooth brown snake. Differences of coloration may be defined as follows:*

*See descriptive key at beginning of article.

Worm Snake	No pattern
Ring-Necked Snake (Has a smooth collar)	No pattern
Smooth Green Snake	No pattern
Keeled Green Snake	No pattern
Blacksnake	No pattern
De Kay's Snake (Occasionally a faint band on back and minute black dots)	No pattern
Storer's Snake	No pattern
Smooth Brown Snake (Minute black dots on back)	No pattern
Hog-nosed Snake (Occasional specimens are black)	Strongly blotched pattern
Corn Snake	Strongly blotched pattern
Pine Snake	Strongly blotched pattern
Milk Snake	Strongly blotched pattern
Water Snake	Transverse bands extending to sides
King Snake	Pale chain pattern
Mountain Blacksnake	Numerous scales narrowly edged with white
Ribbon Snake	Striped lengthwise
Garter Snake	Striped lengthwise
Striped Water Snake; Queen Snake	Striped lengthwise

Seven species have perfectly smooth scales, two have the scales faintly keeled, and with nine the scales are strongly keeled.

Eleven of the species are oviparous and seven are viviparous.

Two species, the banded water snake and the queen snake, are persistently aquatic. The ribbon snake also takes much to the water, or frequents margins of streams and damp meadows.

The hog-nosed snake prefers very dry, sandy areas. This species is the most dramatic in endeavoring to frighten an intruder. While most snakes will glide to safety when disturbed, this species widely flattens the neck and hisses. It will also feign death.

The preceding species and the pine snake are the only local species to loudly hiss when disturbed.

Several of the local non-venomous species will flatten the body and strike, if cornered. Their bites are entirely innocuous beyond the possibility of infection which may result from any small abrasion.

The two species of blacksnakes, the corn snake, pine snake, king snake and milk snake, vibrate the tail when angry, and produce a buzzing sound when the appendage is among dry leaves.

Twelve of the local species feed only upon cold-blooded prey, three upon both cold and warm-blooded prey, and three entirely upon warm-blooded prey. The common green snake appears to be the only species which is altogether insectivorous. While its near ally, the keeled green snake, feeds largely on insects, it also devours small lizards.

The garter snake, De Kay's snake and water snake are the most abundant species.



Fig. 28. A Copperhead Den. This typical formation of shelving rocks at the top of a ledge illustrates the character of place for picnic parties to avoid, and where care should be used in employing the hands when climbing, or if a person is walking about in low shoes, with ankles and legs unprotected. The rocks cover deep, sheltering crevices, in which numbers of snakes may be lurking.

Descriptions of the Species—(*Continued*)

Venomous

The three poisonous snakes coming within the scope of this article are members of the Family *Crotalidae*. In non-technical terms they are called pit vipers, owing to the presence on both sides of the head, between the eye and the nostril, of a deep pit, appearing more prominent than the nostril itself. Another external character renders them unique among the local species. This relates to the form of the pupil of the eye, which is elliptical. With the non-venomous species, the pupil is round. The arrangement of the plates or scales under the tail forms a third differentiation. They occur in a double row, from the vent to the tip of the tail, with the non-venomous species, while with the poisonous snakes, the plates from the vent to the tip of the tail are in a single row, except with the copperhead, where the scales separate into two rows near the tip of the tail.

The Crotaline serpents are provided with a pair of long, hollow teeth in the forward portion of the upper jaw. These are the fangs, which have an orifice at the tip, like a hypodermic needle, for the injection of poison when they are driven into an offending object by a combination strike and bite, or by a deliberate bite alone. A tubular connection from the base or top of each fang extends backward to a poison gland on each side of the head. When the serpent bites, a contraction of the masseter muscle against each gland vigorously squeezes it, forcing poison forward and out of the connected fang. The fangs are on movable bones, and fold back against the roof of the mouth when the jaws are closed. They are covered with a sheath of delicate flesh, which is forced back when the fangs are imbedded in any object.

These pit vipers do not spring or jump at an intruder. They strike from one-third to one-half their length, and almost invariably coil with the neck in an S-shaped, lateral loop, ready to strike from that position. They can as readily strike when crawling, for when disturbed, the neck is usually kept laterally looped for defence. They can also quickly turn and deliberately bite, without recourse of darting the head from a loop. These local species never wantonly attack a human.

All are viviparous, giving birth to living young to the number of about twelve.

The Copperhead Snake, *Agkistrodon mokasen* Beauvois, (Figs. 28, 29, 30). Coloration is vivid and rather characteristic, owing to the separation and fair symmetry of the blotches. The body hue is pale brown, pinkish, or light reddish brown, with a series of large blotches on the sides, somewhat like inverted Y's. These blotches are usually of a rich, chestnut brown. When examined from above, a number of the markings will be seen to unite across the back, producing a continuous pattern across the body, the central portion being narrow and broadening on each side, giving the outline of an hour-glass. The top of the head is without marking, and often slightly paler than the body hue. The undersurface is usually pale, pinkish brown, with a row of dark spots on each side. There is some pattern variation in intensity of the blotches, which may be paler in the central area and outwardly margined (very narrowly) with quite a pale tint, which accentuates their intensity.

Large specimens are about three feet long, but occasional four foot specimens are noted. Curiously enough, the largest specimens which ever came to the writer's attention were captured in the immediate vicinity of White Plains, Westchester County, New York, where an example measuring four feet and five inches, and approximately two inches in diameter, appears to form a record for the species.

The water snake and hog-nosed snake are sometimes mistaken for the Copperhead, owing to their proportionately thick bodies, and gross similarity of markings. The poisonous species, however, carries its points of marked differentiation in having elliptical pupils, prominent cavity or pit between the eye and nostril, and greater number of plates under the tail in a single row. The milk snake is also confused with the copperhead, but is more slender, while the blotches are irregularly rounded and narrowing as they approach the sides, instead of spreading widely, as with the copperhead.

While the bite of the copperhead is very dangerous, and there are records—although they

are rare—of fatalities from such injuries, it is not nearly so poisonous as the timber rattlesnake. Its fangs are proportionately shorter, its venom not so virulent, and the amount of poison injected into a bite of lesser quantity, owing to the serpent's smaller size. In habits, it is very quiet, preferring to lie perfectly still when an intruder enters its lair, and escape detection owing to its pattern and colors closely resembling the fallen leaves around it. Seldom will it make any attempt to strike, unless very definitely annoyed or attacked, or if it is stepped on. Most of the cases of copperhead bites which have come to our attention have resulted from the latter condition, and have related to persons wearing low shoes—many of the bites being on or near the ankles. If a copperhead fears it is about to be attacked, it will impart a rapid, vibrating movement to the tail, and if among dried leaves, produces a distinct, buzzing sound, readily heard for about fifteen feet. It will coil and fight bravely if cornered, but at the first opportunity, quickly turn and glide to safety in some crevice.

Distribution is more extensive than with the rattlesnake, owing to protective coloration and more secretive habits. Copperheads are still found along the top and at the base of the Palisades of the Hudson, while the rattlesnake appears to have been exterminated from that area for close to fifty years. Throughout Pennsylvania and New Jersey, the copperhead is rather generally distributed, except in regions of intensive cultivation. There are various areas of New York state where the species has not been recorded. It is common from the latitude of northern Westchester County, well up the Hudson and past the easterly border of the Catskill area, also in counties to the west. While showing a decided preference for mountain areas, as illustrated by its abundance in elevated regions of New Jersey, Pennsylvania and Connecticut, it does not occur in the Catskill Mountains proper, and in but few portions of the Berkshires; or in the general area of the Schwangunk Mountains, in Sullivan County, except on the easterly side of the Neversink River, although it is quite evident and increasing in abundance along the Delaware River. It is common in Connecticut, both along the shore and in elevated regions, also in the coastal area of Rhode Island. The species does not extend northward of central Massachusetts, hence may be eliminated from consideration in the states of Vermont, New Hampshire and Maine.

Ledgy, wooded hills, with a base of wild, damp meadows, form the favorite prowling grounds of this snake, as it searches for small rodents, birds and frogs. During the summer it is often seen along old stone walls, which might offer shelter and a congregating place for rodents. With the autumn, it returns to specific crevices among the rocks, to hibernate, and it is close to such locations that the young are born during August or early September. From six to nine young are produced in a litter, and the tails of the infant snakes are bright, sulphur yellow.

General range: Central Massachusetts to northern Florida; westward to Texas.

The Massasauga, *Sistrurus catenatus* (Rafinesque), (Figure 31), might be regarded as somewhat of an intruder among the local serpents, as it is essentially a western species, and is found only in a limited area in western New York. It is a small rattlesnake, which may be easily told from the widely distributed timber rattlesnake, by the large and symmetrically arranged plates on the top of its head—quite similar to the head plates of a harmless serpent. Its rattle, of course, provides a point for immediate identification. The ground color is brown, or grayish, with a series of chestnut-brown, symmetrical, oval blotches on the back, becoming darker toward the edge and narrowly outlined with a paler hue. There is a smaller row of rounded blotches on each side. The usual length of the Massasauga is from two to three feet.

Mr. Edward T. Whiffen, who has been much interested in the occurrence of this reptile in New York state, has written about it in the New York Zoological Society Bulletin as follows:*

"The Massasauga, a species of dwarf rattlesnake, is still to be found in New York State, in and around Cicero Swamp, which, with some interruptions, stretches across the northern parts of Onondaga and Madison Counties, between Oneida and Onondaga Lakes. The main

*Vol. XVI, No. 55.

swamp is said to be fourteen miles long and seven miles wide in its greatest extent. It consists of the swamp proper, in which are numerous 'islands,' or higher areas of land. Next to the dry land is the 'shore,' a wet, marshy strip, from seventy-five to one hundred yards wide. Beyond the 'shore' is the swampy land proper, fairly dry in summer and covered by a dense growth of trees, bushes, ferns and moss. In some places this moss is knee-deep. Many of the bushes are of the huckleberry variety, and it is among these that the Massasauga is frequently seen in August and September, when berry-pickers go out into the swamp.

"The Massasauga seems to like the neighborhood of swamps, though it shuns the actually wet places. In the harvest season it is usually found either in the hay-fields or oat-lots, or it may be seen out on the moss among the bushes, or under the evergreen trees. However, it may occur almost anywhere. A gentleman told me that two years ago he found a large Massasauga in his wood-pile, about six feet from the house. Others reported having found the snakes in their cellars, or under the steps. There is an abundance of frogs and mice in the meadows, and frogs and birds in the swamp; and such conditions account for the presence of the reptiles in those places. In the hay-field the Massasaugas seem to select the damper spots, where the growth of vegetation is heaviest. There they are frequently cut in two by the knives of the mowing-machines. Newly cleared fields, where there are plenty of stumps and berry bushes, are also favorite lurking places of this reptile, which is sometimes seen sunning itself on a stump, or lying coiled among the bushes.

"Older residents assured me that the snake is much less common than formerly, when its range extended over the entire northern part of the county. Its disappearance is due probably to ceaseless slaughter and to the draining of the swamps. That it is still fairly common may be judged from the fact that the killing of a dozen snakes in an area of perhaps a hundred acres was reported within the space of two weeks' time. One of these snakes had sixteen rattles and two had ten. Six or eight was a common number. The whole region is abundantly supplied with reptile life, milk snakes, ribbon snakes, garter snakes, water snakes, etc., being of frequent occurrence. As much of the swamp has little value for tillage purposes, and as the timber is small and comparatively worthless, the massasauga, though in diminishing numbers, will probably continue to be found in the region for some time."

General range: Western New York to Nebraska; northward into Michigan and Ontario; southward to Texas and northern Mexico.

The Timber Rattlesnake; Banded Rattlesnake, *Crotalus horridus* LINNE, (Figures 34, 35). In pattern and colors, this species presents great variation. The most familiar phase is that of sulphur yellow or pale tan ground-color, with wide, dark brown or black cross bands, usually wavy, or pointed to the rear, and sometimes broken into three series of blotches, the central or larger ones being rather rhomb-like. The tail is black.

The blotches on some specimens are narrowly margined with a paler hue. The ground-color varies from yellow to brown and olive. Some specimens are so suffused with black that the bands are indicated only by their pale margins. Specimens of a uniform, velvety black, are not rare. Blackish and pale yellow specimens are usually associated in the same den. The greater number of the black specimens are males, although there are some melanistic females. We have never noted any pale yellow male examples. These large yellow or tan specimens thus appear to be invariably females.

The average length of the adult timber rattlesnake in the northeastern states is slightly under four feet. As with a number of species of serpents, however, a specimen may well exceed the usual run. The largest specimen I ever examined was two inches over six feet in length and nearly three inches in diameter. It was taken near Sheffield, in the Berkshires. A specimen nearly as large (slightly under six feet) was taken near the top of the great rock slide near Hartsville, Massachusetts, which shattered ledge is alleged to have inspired Oliver Wendell Holmes' description of "the mountain" in his classic novel, "Elsie Venner." Large specimens have been recorded from New Jersey and Pennsylvania.

Distribution of the rattlesnake in the northeastern states is associated with hills and mountains of moderate height, on which there are

broken ledges with large, loose fragments on the slopes and top. These flat fragments may be a foot or more in thickness and from a yard to six or eight feet in length, sloping back into a fissure the bottom of which may be covered with soil or leaves, and which provides a position of security during storms. It is the common habit of rattlesnakes to coil under the edge of these rock masses, protected from the too-hot summer sun, and ready to quickly retreat if disturbed. If the intruder goes on his way, the snake may lie in its motionless coil, without sounding the rattle, thus seeking to escape notice.

Near these natural homes, are specific crevices or "dens," where rattlers that have roamed over a considerable area during the summer, congregate each fall preparatory for deep penetration and hibernation, beyond the frost line. During the late summer the females return to such places and here the young are born, with a natural instinct to return to this specific spot each year for winter shelter. From the areas of the ledges, many rattlesnakes prowl through the forest areas for food, and often into the farmlands. Variations in weather conditions produce marked difference in numbers observed. During particularly dry summers, they may come into the low grounds for water, in considerable numbers. Their natural prey, small rodents and birds, sometimes shift their feeding grounds and this also affects the summer distribution of the rattlesnake. If a farm is infested with rats and mice, and a rattlesnake den is not far distant, it will not take the reptiles long to discover the favorable feeding ground. They may also be commonly noted during the haying season, due to the presence of large numbers of field mice.

While a very dangerous snake from the standpoint of its large fangs and the amount of venom it is able to inject at a bite, the northern rattlesnake is a rather inoffensive reptile as compared with its larger allies in the southern states. It almost invariably gives warning of its presence by sounding the rattle, if disturbed when out of immediate contact with a sheltering crevice. If closely approached, it will strike, but the full striking distance of the average specimen is barely eighteen inches—and usually shorter. There are records of fatalities from the bite of this species, but generally considered, in the northeastern portion of its range, there is a surprisingly small number reported, less than with the copperhead, which gives no warning of its presence. In an area of the southern Berkshires, where rattlesnakes are particularly frequent, the writer has records of but three bites during a period of about twenty years. One of these was fatal.

Distribution is general in the wilder, hilly country, with the exception of the Catskill and Adirondack Mountains. As far as we are aware, no rattlesnake has ever been recorded from the Adirondack Mountains proper, although the species is quite common on Tongue and Black Mountains, in the vicinity of Lake George. Likewise, the only recent Catskill records come from Tremper Mountain, at the edge of the Catskills, near Phoenecia, New York. The species is abundant in the Ramapos (where, however, accidents are extremely infrequent), the Kittatinnies of New Jersey and Pennsylvania, and the Swangunk range in New York. In central New Jersey it occurs in conditions rather curious for a mountain type. There is considerable flat, forested country back of the central coast, quite damp in spots and with large sections covered with heavy sphagnum moss. In these locations, the species attains a considerably larger average size than the mountain type and exhibits a slightly different coloration. It is grayish, with strongly contrasted black bands, and a faint, rusty, dorsal stripe, several scales wide. There is a resemblance to the southern race known as the sanebreak rattlesnake, which, in the costal area of the Southeast and the lower Mississippi Valley attains a frequent length of close to eight feet and has a distinct reddish band along the back.

Rattlesnakes are extremely rare in the state of Maine, and that area is thus unique among all the states in the virtual absence of poisonous serpents. The Boston Society of Natural History has been unable to obtain a record specimen for its collection, from Maine. There appears to be a few records from New Hampshire, and specimens are reported on an island in Lake Winnepesaukee. Vermont seems to have few specimens, except along the westerly slopes of the Green Mountains and in the southern portion of the state. Both the cop-

perhead and rattlesnake appear to be extinct on Long Island, although that the latter was formerly found there is evident from skins and rattles among the trophies of old farm houses. We have been unable to verify the occurrence of a specimen of either species during the past thirty years.

General range: The central portion of the New England area, southward to northern Florida; westward to the Plains.

* * *

Precautions Against Accidents—A pair of stout, canvas leggings or leather puttees are positive protection to the legs against northern poisonous serpents. The leggings, however, should be worn with high shoes. If low-cut shoes are worn, there are usually several inches of the ankle left exposed—and this is the part of the limb most frequently bitten.

With the legs protected, it is well to bear in mind that the practise of using the hands in climbing rocky places or getting over a stone fence is dangerous, unless each hand-hold is investigated, with due thought of crevices or hollows that may secrete a coiled serpent. Any thick, brushy place, or pile of leaves, in the wilder country, should be considered a hazard, unless the eye is keen in noting where the hand is directed.

In establishing a summer camp, it is well to ascertain from local residents whether or not there is a particular prevalence of poisonous snakes. We have several times been consulted about camps which have unconsciously been located in the immediate vicinity of a den of rattlesnakes or copperheads, with the consequence that a number of city children, unfamiliar with woodcraft, have been turned loose in an area over-run with poisonous reptiles. There are many ideal locations for camps where poisonous serpents are seldom reported, and the finding of such areas is not difficult. There are also fine camping areas in most of the states under consideration, in which no poisonous snakes are ever to be found.

While the edification of young people in camps about the wild types of life found in the nearby country is highly desirable, instructional measures relating to poisonous snakes have been a bit overdone. This relates to the exhibition of numerous living specimens, and the handling of these in what is considered to be a safe way, to show the poison fangs, etc., the carrying of such specimens to lectures, and the like. Too much of such familiarity reduces respect for danger and it has been noted that a rather large following of boy students has been inclined to transport poisonous reptiles in anything but a thoroughly competent and cautious manner. Several accidents have resulted from this undue familiarity. Camp instructors should be cautioned not to go too far in this direction, to caution boys not to deliberately collect poisonous serpents, and not to harbor such creatures for observation. A captive poisonous snake, except in the care of a competent person, is a source of danger to the possessor and those around him.

* * *

Treatment of Snake Bite—Through the formation of the Antivenin Institute of America, and the guidance of Dr. Afranio do Amaral, Chief of the Brazilian government's Instituto Butantan, specific serum for the bites of the poisonous snakes is being regularly produced in the United States. This product should be located at all points of particular hazard.

It is made by injecting horses with small doses of snake venom, the process continuing through a number of months until the animals have developed a high degree of immunity. Blood is then obtained from them, in small quantities, and is subjected to a number of processes. The red is separated from the serous portion, and the latter is filtrated. Simply explained, the action of this serum, injected into the human victim who has been bitten by a dangerous snake, is to neutralize the poison of the reptile. Its effect is rapid and quite astonishing in relieving the dramatically alarming effects of snake bite.

Serum may be injected immediately after a bite, or up to the time the victim has approached a condition of collapse. It is then usually too late to be properly taken up by the circulation and thus neutralize the poison injected at the time of the bite.

The bite of a copperhead or massasauga is not ordinarily fatal, although it may be very serious. Serum may be injected as late as a day or even two days after the symptoms of great swelling have developed. It is far better,

however, to inject it as soon as possible after the bite, in order to quickly neutralize the poison and thus prevent great destruction of tissue and the red cells of the blood stream. This assures against an extensive necrosis of the bitten area.

A large specimen of the timber rattlesnake may inject enough poison to cause death within ten to twelve hours, and in a much shorter time if a vein is actually struck, which is a rare, but possible condition.

As the bite of a poisonous snake is no more or less than a simultaneously double injection by two hypodermic teeth (the fangs) the measures to meet the emergency should be quick and positive. A ligature of some type should be bound a moderate distance above the bitten part, to prevent the poison being absorbed into the upper limb. The ligature may consist of a strip of cloth, a large handkerchief, or even a piece of heavy cord. A rubber ligature is much the best. There is necessity of making the ligature sufficiently tight to indicate a stoppage of circulation. Even moderate pressure tends to localize the area of poisoning.

With the absorption of the poison retarded, the fang wounds should be opened by an incision across them to an estimated depth of three-eighths of an inch for a large rattlesnake, or a quarter of an inch for a Copperhead. The incision should be made with care not to injure the delicate skin covering a bone, or to cut into a blood vessel. If no cupping device is at hand, drainage should be induced by sucking the wound, there being practically no danger from this if the lips and mouth are free from sores.

After these immediate emergency measures for eliminating as much poison as possible from the vicinity of the wound, the serum should be administered. It is provided in tubes which are actually small hypodermic syringes, and it is only necessary to attach the needle and the handle. The serum is *not* injected in the vicinity of the bite, but under the skin between the shoulder blades or on the abdomen, by what is known as subcutaneous injection. In this way it is quickly taken up by the general circulation. The entire contents of a tube should be injected for a bite. If symptoms are particularly grave, two tubes may be necessary. Intravenous injection might be advisable if the poison fangs have punctured a blood vessel, but this should be done only under the direction of a doctor who has actually diagnosed the condition.

The ligature should be slacked off every ten minutes or so, to induce bleeding at the wound. If no serum is available, the treatment of suction and the frequent slackening of the ligature should be continued, and additional drainage incisions, upward from the injury, are necessary if the swelling greatly increases. If a good cupping device is at hand, the incisions should be rather short and cruciform, so as not to extend beyond the suction surface of the device and thus admit air. It is well to wash the incision with a *mild* solution of permanganate crystals in pure water (to produce a pale amethyst hue), as this fluid will neutralize by oxidation what venom it may reach. The use of strong solutions of permanganate of potassium, however, is not only unwise, but dangerous, as there is much tissue destruction by this chemical at a high strength. This caution also points to the utter rashness of rubbing pure crystals of permanganate into a wound. Moreover, such a wound should never be cauterized. Nothing should be more foreign to the treatment of snake bite than such practice, which actually seals the destructive poison within the tissue.

As not only the immediate area of the wound, but a considerable portion of the neighboring tissue is much weakened and subject to bacterial invasion, and the bite itself is sometimes attended by specific infection with germs from the snake's mouth, the wounds should be covered with a heavy layer of wet dressing, and kept saturated with a mild antiseptic solution. This not only retards or prevents infection, but induces copious drainage, through a discharge of quantities of serous fluids which always appear to be rushed to such a poisoned area.

There are but few spots in the whole northeastern area where poisonous snakes occur, which are not accessible, within a reasonable time, to the aid of a physician, and the snakebite victim should, if possible, make contact with skilled hands to carry through all but the preliminary measures of treatment.

A first-aid kit for the treatment of snake bite should contain the following articles: Several one-sided safety razor blades; a small bulb and cupping glass for flat surfaces, with additional attachment for "round" surfaces, like a finger; a roll of rubber ligature; a small roll of bandage; and two tubes of antivenomous serum. The serum will remain efficacious for several years. A few permanganate crystals may also be carried. Whiskey is useless as a cure, although a moderate dose of medicinal brandy does no harm and may greatly relieve the mind during a situation which may not be nearly so dangerous as it seems.

We have noted the bites of copperheads to produce great swelling which cleared up within a few days with no other treatment than a drainage incision across the fang wounds, and the covering of the area with a wet dressing. There are also cases of both copperhead and rattlesnake bites being treated with the serum and the patient going about his regular business the following day. Again, there are records of grave manifestations. Consequently, poisonous serpents warrant great respect, caution in investigating their lairs, and personal protection in going through the areas which they inhabit.

As many people are bitten by harmless snakes which may quickly glide away, leaving apprehension behind them, it is well to understand that the bite of a poisonous serpent is unmistakable. A harmless serpent may produce distinct wounds from its recurved teeth, and as but a few teeth may cause lacerations which bleed, the imagination of a nervous person may quickly classify two "fang" punctures. If nothing happens within ten minutes following a bite, the snake was harmless. A bite from a poisonous serpent develops rapid symptoms. A burning pain is apparent within three to five minutes, and within ten minutes there is a distinct swelling. This rapidly increases, and is usually followed, within half an hour or less, with profuse perspiration and there may be reflex vomiting. By this time, of course, emergency treatment should have been given, and if serum is at hand, its injection may prevent the more alarming symptoms.

Books of Reference on Serpents

The following list of books may be consulted for a more extensive study of serpents and other reptiles:

REPTILES AND AMPHIBIANS: THEIR HABITS AND ADAPTATIONS ..... *Thomas Barbour*
Houghton Mifflin Company, New York City.

CHECK LIST OF NORTH AMERICAN AMPHIBIANS AND REPTILES (Technical)
Leonhard Stejneger and Thomas Barbour
Harvard University Press, Cambridge, Massachusetts.

REPTILES AND BATRACHIANS ..... *E. G. Boulenger*
E. P. Dutton & Company, New York City.

THE CROCODILIANS, LIZARDS, AND SNAKES OF NORTH AMERICA (Technical) *Edward Drinker Cope*
United States National Academy of Sciences, Washington, D. C.

THE REPTILE BOOK (REPTILES OF NORTH AMERICA) ..... *Raymond L. Ditmars*
Doubleday, Doran & Company, Garden City, Long Island, New York.
(Temporarily out of print. On file in the larger libraries.)

REPTILES OF THE WORLD ..... *Raymond L. Ditmars*
The Macmillan Company, New York City.

AMPHIBIA AND REPTILES ..... *Hans Gadow*
The Macmillan Company, New York City.

THE POISONOUS SNAKES OF NORTH AMERICA ..... *Leonhard Stejneger*
United States National Museum, Washington, D. C.

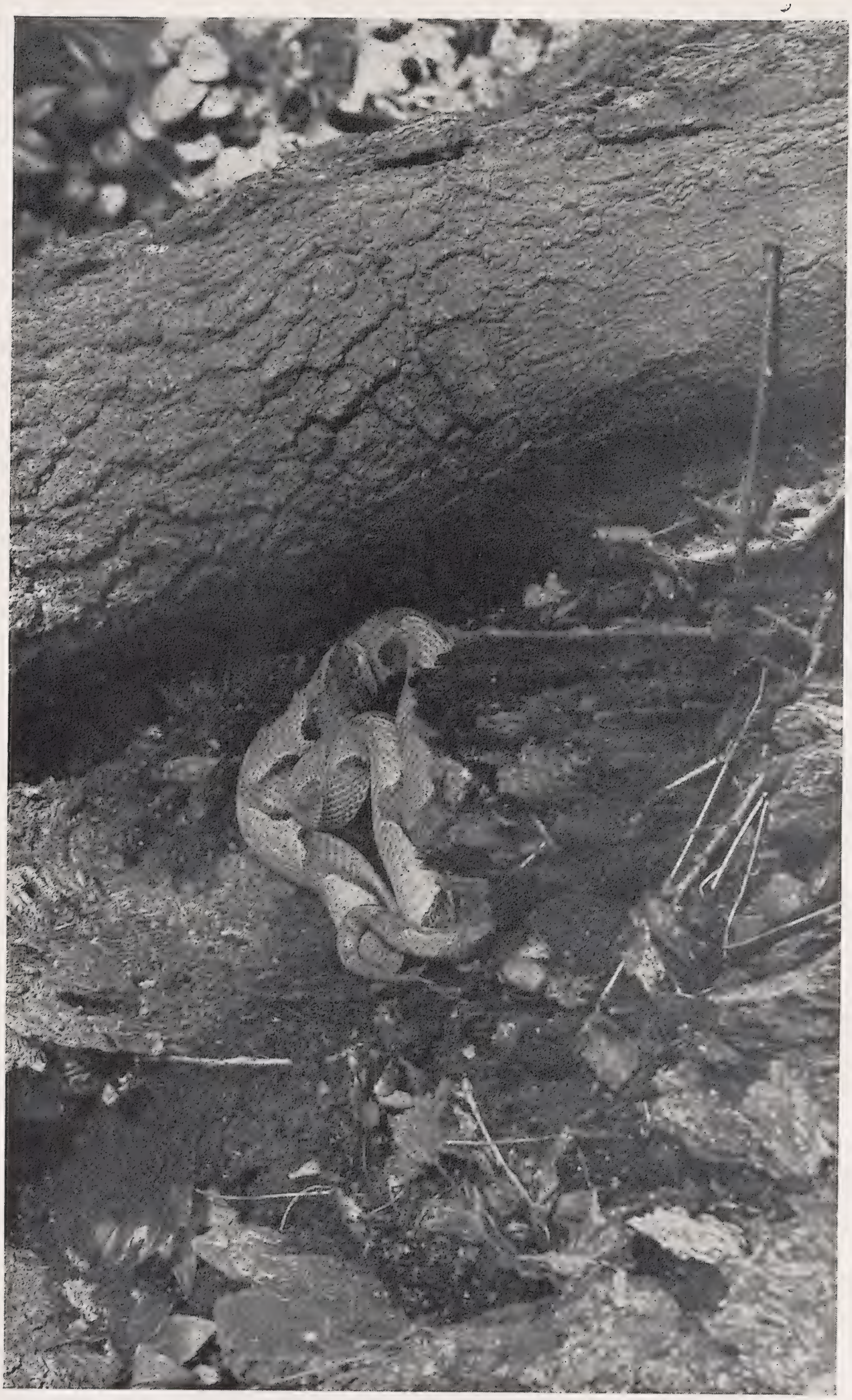


Fig. 29. A copperhead blended with the tints, tones and shadows of its lurking place. These dangerous snakes are extremely difficult to see when coiled among fallen leaves, which is a common habit. All of this goes to show the necessity of care in placing the hands in picking flowers or climbing, or in walking through brushy places with thin stockings and low shoes.

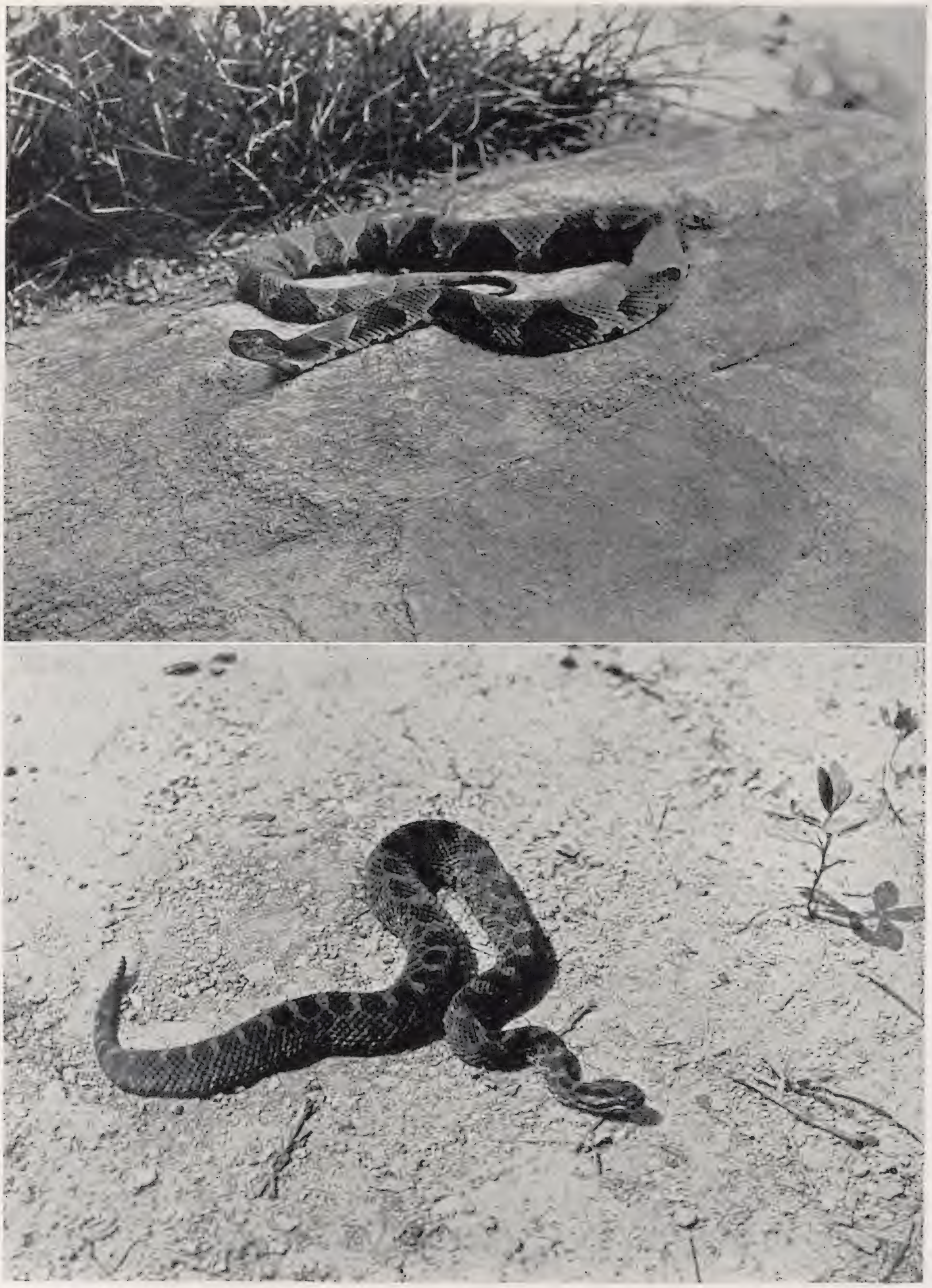


Fig. 29. Copperhead Snake, *Agkistrodon mokasen*. Coloration is vivid and rather characteristic. The body hue is pale brown or reddish brown, with large blotches on the sides like inverted "Y's." These are of rich, chestnut brown. Examined from above, a number of the markings will be seen to unite across the back, giving the outline of an hour glass.

Fig. 30. (*Lower*) Massasauga, *Sistrurus catenatus*. A small rattlesnake which ranges easterly into the local area in a limited portion of western New York. Its rattle is an immediate point for identification.

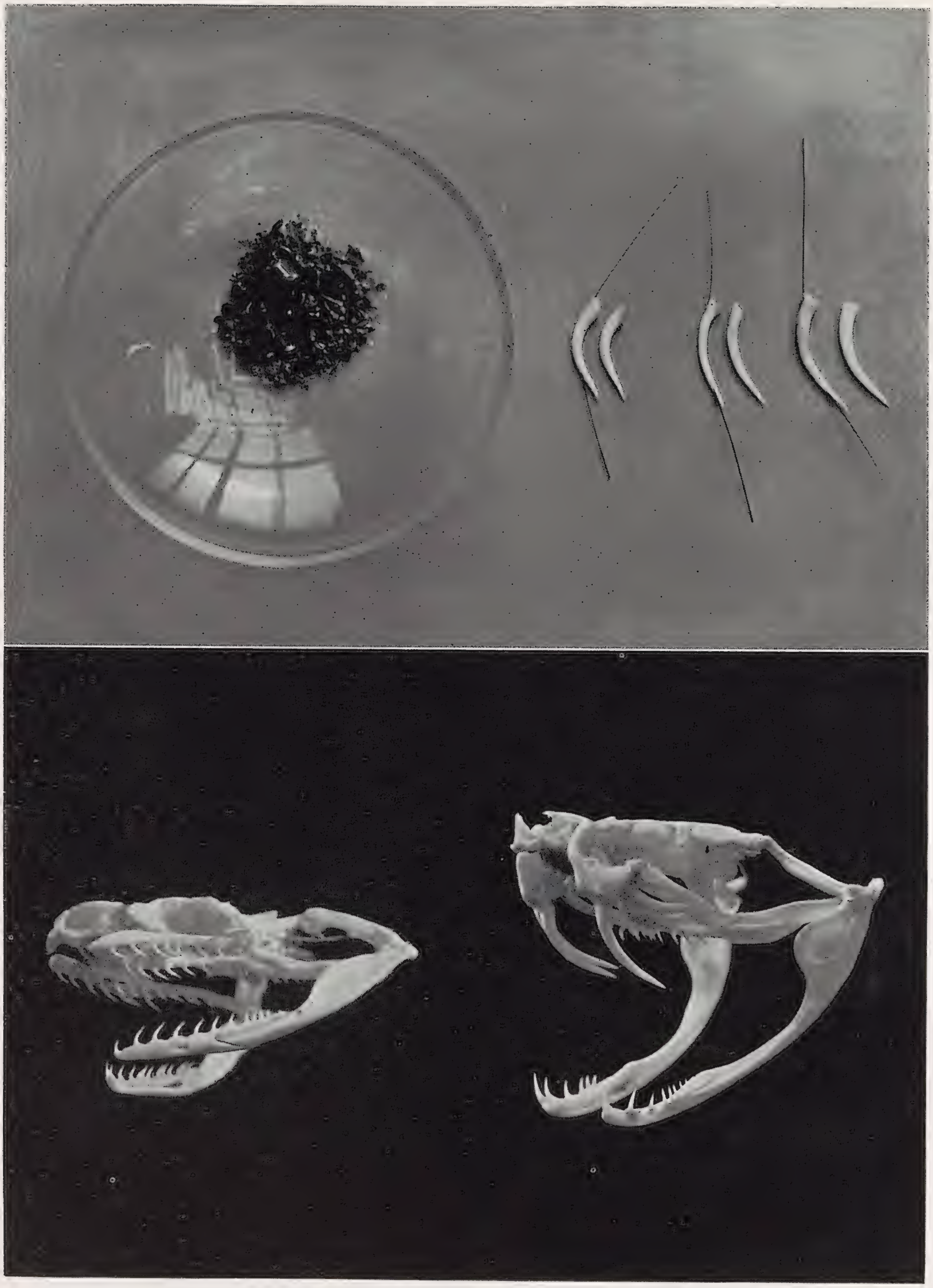


Fig. 26. Dried crystals of rattlesnake poison. It is dehydrated after extraction from the snake to prevent decomposition. When used for immunization in producing antivenomous serum, it is quickly soluble in distilled water. It retains its potency for months or years in a dried state. (*Right*) Fangs of Rattlesnake, Fer-de-lance and Bushmaster, with horsehair passed through the orifice which extends from tip to the base, to show the resemblance to the hypodermic needle of the surgeon.

Fig. 27. (*Lower*) Skulls of harmless and poisonous serpents. The latter shows reserve fangs and a double fang on right—one of these about to be shed.

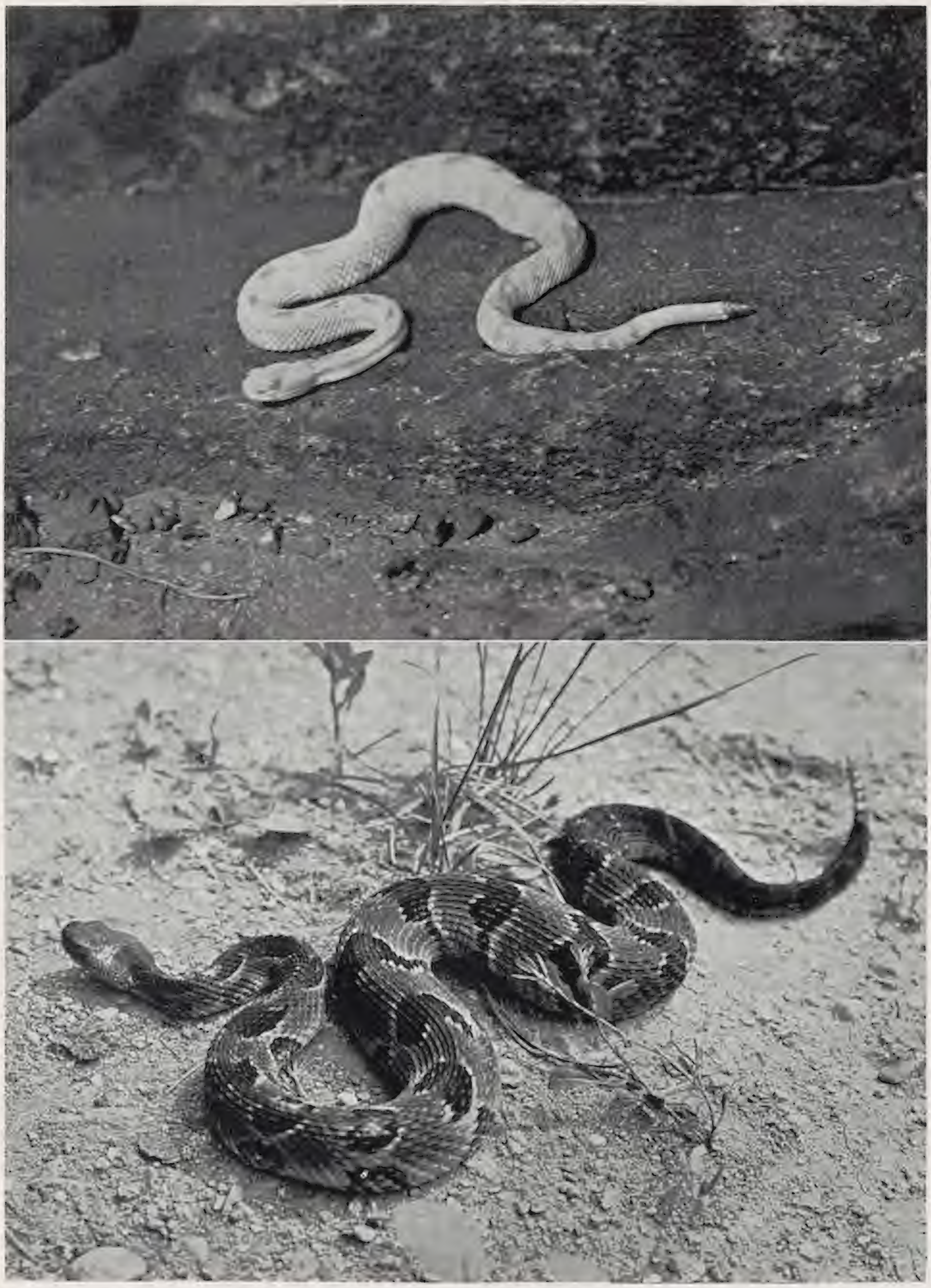


Fig. 31. Albino Timber Rattlesnake, *Crotalus horridus*. Albinism among serpents is fairly frequent. This specimen was discovered at Black Rock, near Sheffield, Massachusetts. It was twenty-five inches long. A second specimen, apparently a year older, was found at the same den the following year.

Fig. 32. (*Lower*) Timber Rattlesnake, *Crotalus horridus*. Typical example of the species of rattlesnake broadly distributed over the northeastern area in the neighborhood of mountains and ridges. Yellow and blackish examples are equally common.

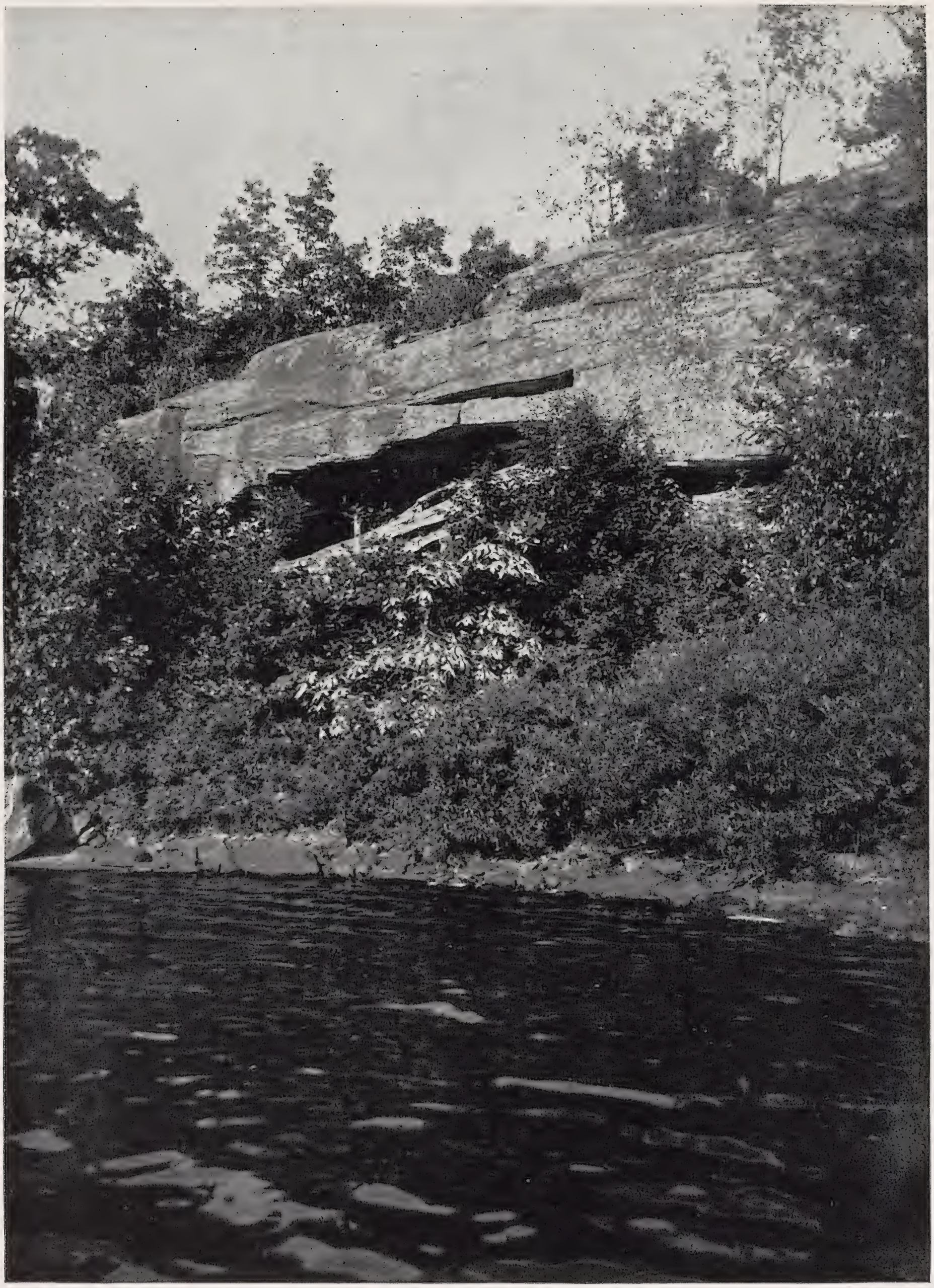
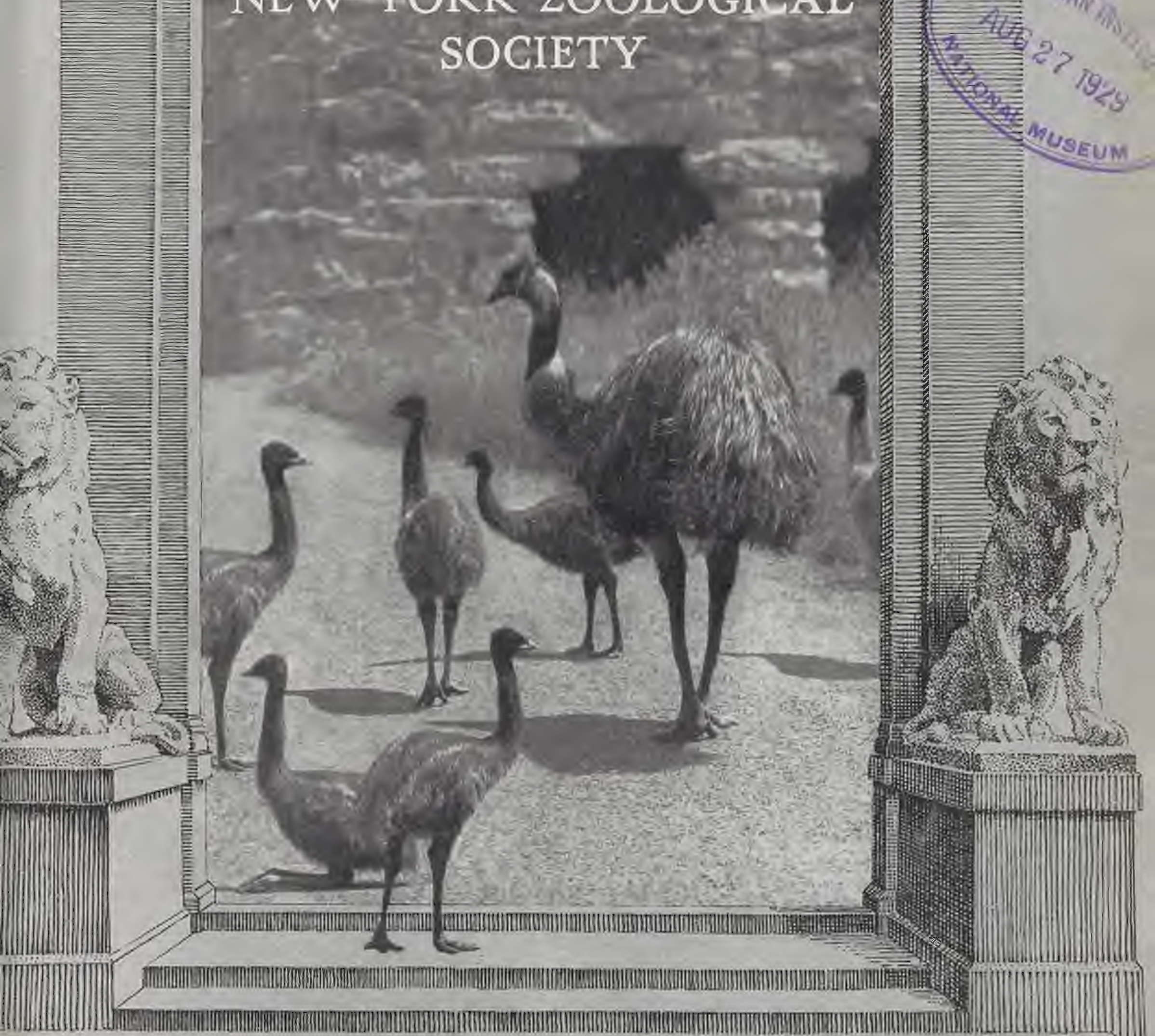


Fig. 33. A Rattlesnake Den. Portion of a ledge in Sullivan County, New York, which extends a distance of several hundred yards, with numerous lesser ledges behind it. The top is covered with loose, shelving rocks, many of them covering deep crevices. The great fissure in the center is about five feet high and extends in about twelve feet, when it narrows to a crevice of great depth. Numbers of rattlesnakes congregate at this den every autumn, to hibernate.

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The Hoatzin (*Opisthocomus hoazin*) or *cigana* as it is known locally, is quite common along most of the rivers and *igarapés* of Marajo. Many attempts have been made to bring this primitive bird to the zoos of the United States and Europe, but thus far it has not proved successful. The bird does not flourish in captivity. Further information concerning the Hoatzin may be found in Zoologica Vol. 1, Nos. 2 and 3, Tropical Wild Life, and Bulletin for September 1916: publications of the Society.

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Marajo, The Wonder Island of Amazonia

Part I. Description of the Island and Its Environs

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The illustrations are from photographs taken by the author unless otherwise noted.

THERE certainly must be few, even among the less-informed, who do not carry in their minds at least a vague conception of the Amazon, the mightiest of all the world's waterway systems. On the other hand, I venture to say that there are a far less number who know that within the very maw of this Titan of all rivers, lies the wonder island of Marajo, the terrestrial Noah's Ark of Amazonia, with an area comparable in size to the Kingdom of Denmark. Truly a wonder island, with more than a hundred miles of coastline caressed and cudgeled by the broad Atlantic, and where ships at sea can fill their casks with fresh water, a phenomenon unknown in any other spot in all Christendom.

If we are to consider the Rio Para—its only navigable gateway—as one of its true mouths, what constitutes the mouth of the Amazon is more than one hundred and eighty miles in width. Some hundred miles of this great expanse, however, is occupied by the north shore of Marajo. This only port of entry for sizable vessels, known as the Bahia do Marajo, the estuary of the Rio Para, stretches for thirty-five miles from Cape Magoary, the extreme northeast point of the island, to the town of Salinas on the mainland to the southward.

I shall never forget my first glimpse of the distant shore line of this remarkable island. To me, after nineteen days out from New York aboard a slow passenger carrying freighter, even land was a welcome sight, and behind those verdant barriers seemed to me a promised land where I should find a paradise for the field naturalist and hunter for archaeological treasures. Yes, and the ensuing months were to prove, for once at least, that realization can exceed even the most highly colored anticipation. As we lay at anchor in the open sea waiting for the pilot boat to come out to us from Salinas, I could see from the bridge through my glasses, many small fishing boats scudding along the coast of the island against a background of glistening strand and the greens of the forest. I could but wonder what adventures might await me behind this jungle fringe.

One of my fellow passengers, a Japanese scientist with a keen sporting instinct, offered to wager ten yen that the pilot would put his left foot over the rail first. I foolishly accepted, for somehow I never can win bets like that. I remember when going home one day from prep-school with another boy, he bet me a dollar he would see more dogs than I would see cats before reaching a certain street corner. Just as we approached the appointed spot, I was full of juvenile joy, for I had him three down and he was preparing to hand me the much coveted dollar. But alas, and without warning, the dog-



Marajo is the largest and by far the most important of all the islands that make up the vast delta of the Amazon. Just below the Equator, this island, in area almost the size of the Kingdom of Denmark, lies in the very mouth of the greatest of rivers, bounded on the west by the Amazon and on the east by the Rio do Para. This latter river is twenty miles wide opposite the city of Belem, as Para is more properly known. The island of Mexicana, just to the north of Marajo, is more than thirty miles in length, which gives a good idea of the size of the greater island and the extent of its shore line stretching along the Atlantic.

Map through courtesy of the American Geographic Society.



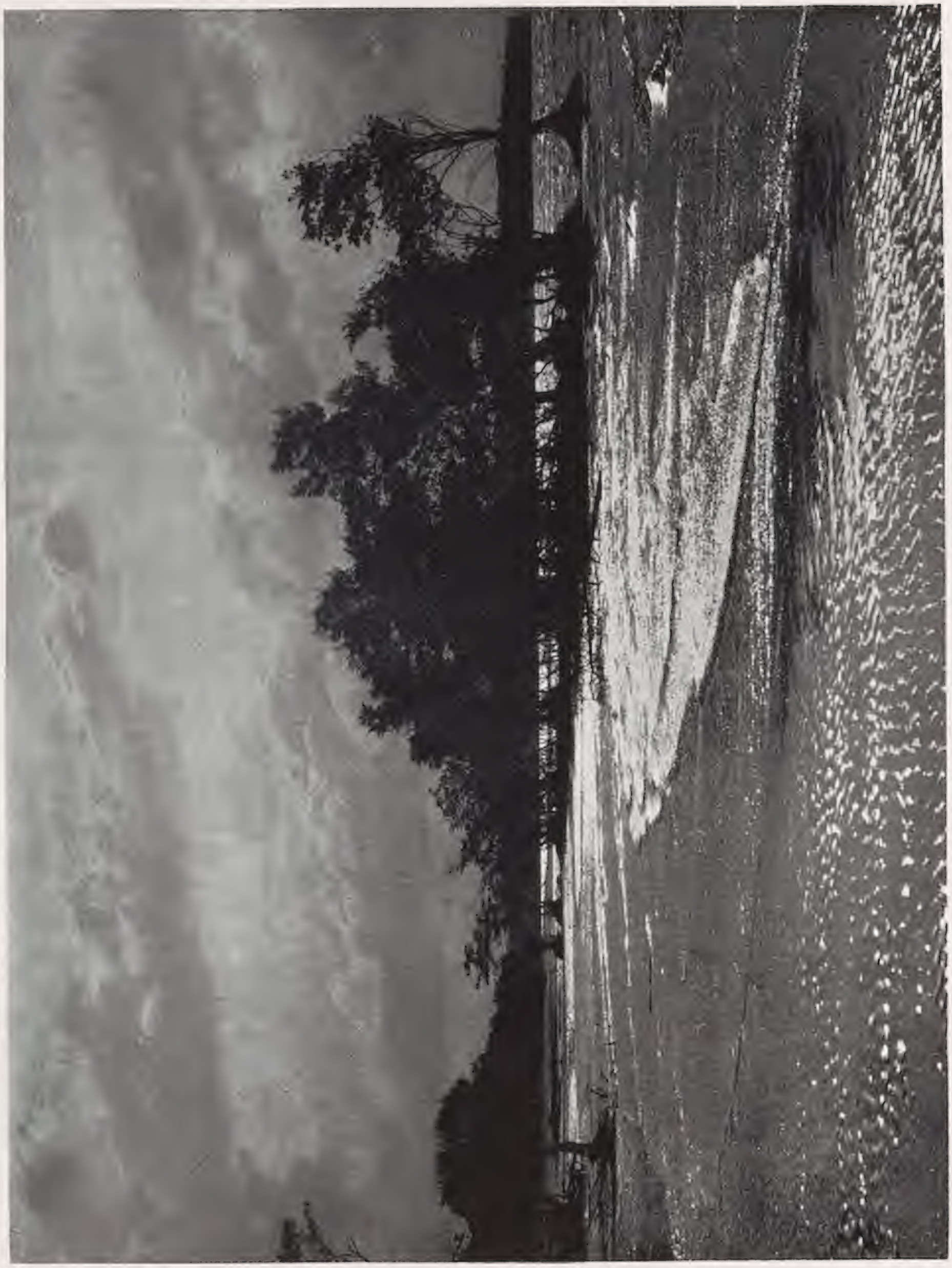
Against the glistening strand and greens of the forest, fishing boats scudded along. In one of these sturdy single masters we made the voyage from Para (Belem) to the Rio Cambu, which enters the Rio Para about twenty miles southwest of Cape Magoary, the extreme northeastern point of Marajo.

catcher's wagon turned the corner and swept by with a full load of unfortunate barking freight. It always has been that way with me. The pilot put his worst foot forward, and my five dollars winged its way eastward.

It was late in the afternoon when the pilot came aboard, and we weighed anchor. The atmosphere had become quite oppressive, and large cumulus clouds commenced forming to eastward, their edges fast darkening. Then without warning, the entire horizon became fringed with the hue of indigo, rapidly spreading upward to blot out all vestige of sun. Then came the wind. As it swept along the shore of Marajo, I could see through my powerful binoculars, the tall burity palms bending with its force. With their fronds waving they reminded me of fleeing humans, wildly tossing their arms in the frenzy of despair. Rapid flashes of lightning, crashes of thunder and then the rain—rain in deluges.

Almost as quickly as it had come upon us, the squall had passed, and as the sun again appeared, only distant rumbling and faint flashes reminding us of its visit. The tense, almost unsupportable atmosphere had also vanished with the storm, and in its place came a cool refreshing breeze. To the westward hung violet tinted clouds, draped like huge valances and curtains edged with burnished gold, slowly drawn aside to disclose a scape of phantom hills and valleys, fringed by lakes of lapis lazuli. Then the sun rapidly dropped beyond the deep emerald barriers of the island's shore, and the entire horizon from every compass point was a blaze of spectrum color.

Many carry in their minds the erroneous idea that there is no twilight at the Equator; that night comes like the pulling down of blinds, or the turning of an electric switch. It is true that you do not have the slowly lengthening shadows of our northern mid-summer evenings, and that these equatorial twilights last but for a few fleeting minutes—but what splendid, what gorgeous twilights they are—preceded by sunsets rarely equalled, and never surpassed by any in all the world. Such a sunset I saw that night, and even as the stars commenced to appear, the



From Cape Magoary, the coastline of Marajo stretches westward for more than one hundred miles, swept by the waters of the mighty Atlantic. It is off this coast, where the power of the Amazon's mighty flood is so great, that sailing vessels in need of fresh water may fill their casks at sea; a thing unknown elsewhere in all the world.



Just as the pilot came aboard in the late afternoon, the atmosphere became oppressive and large cumulous clouds formed to the eastward, spreading upward to blot out the sun. Then came the wind and the rain. When it had passed the violet tinted clouds slowly swept aside to disclose the phantom hills and the setting sun which slowly dropped behind the barrier of the shore.

beauty of its last glow seemed to linger like the aftertones of cymbals.

What constitutes the delta of the Amazon is made up of a great labyrinth of islands, grouped between Marajo and the northermost, or true mouth of the river, which pours its flood of yellow water into the Atlantic through many great channels. With four times the volume of the Mississippi, the great stream of this mighty flood discolors the green surface of the ocean for sometimes more than a hundred miles to seaward. These channels flow to the northwest and north of Marajo, and while they are the main arteries, they do not accommodate all of the Amazon's tremendous outpouring of turgid muddy water, a considerable volume seeking an outlet through a vast system of *furos* (smaller channels) to the west and south of the island. It is these furos that link the true Amazon with the Rio Para, all subject to the ebb and flow of the tides.

The largest of this vast delta is Marajo. Not only in size, but in many other respects, it stands forth in distinct contrast to all the other islands large and small; the wonder island of this delta group. Like Gurupa and the many even less important islands in this maze, the western side of Marajo is the result of countless centuries of alluvial deposits, and represents Amazonia in its most pestilential and defying aspect. It is here covered by dense insect infested and fever ridden jungles, subject to inundation annually during the flood time of the great river. Along the borders of this dismal wilderness, timber, rubber and oilseeds are worked to a certain extent, but here certainly, living conditions appear at their very worst. A less healthful region could not support human life. On the other hand, the eastern side of the island is a vast, and for the most part, a healthful expanse of practically all open *campos,* stretching to the Atlantic coastline on the north. Over this section roam more than half a million wild and semi-wild cattle and horses. It seems unquestionable, but that this eastern half of Marajo is a remnant of the original *terra firme,** or main land, and not a more recent alluvial accretion as is true of the western portion. If

* Portugese.



Upper—Low-lying Marajo is in the path of the constant trade-winds from the Atlantic, and in many places over the open *campos,* the wind-swept trees have been changed into curious and grotesque shapes by the resistless force of these steady winds. *Lower*—A typical *teso,* or sparsely timbered oasis in the *campos.* At such points, the ground is sufficiently high to be above the inundations during and following the rainy seasons. Here also may be seen the effects of the trade-winds in the gnarled and twisted tree-trunk.

I remember correctly, Agassiz took samples of the soil at Souré, on this eastern side, and found them to correspond with similar tests made of the formations on the mainland directly across the Bahia do Marajo.

This eastern shore of the island rises well above sea level, gradually sloping westward over miles and miles of campos, to at last drop into the Mondogas, as the dismal swamps on the eastern fringe of its westward jungles are called. Although this vast campos region is flooded for about eight months of the year, this inundation is entirely due to the long rainy season, as this eastern section is in no way affected either by the river's annual flood or by the tides.

In Para, only seventy miles distant from the town of Souré, the most important settlement on the island, rain occurs every month throughout the year, while in Marajo, the months of October, November and December are absolutely rainless. This unusual phenomenon causes this campos country to go through a sort of Jekyl and Hyde metamorphosis as the year progresses. There are, for example, large stretches of country where during the month of June one can travel in a shallow draft sailboat. Returning in December to the same locality, it would be hard to realize, as you galloped on horseback over the parched prairie, that you had ever visited this same region before.

Scattered over this vast campos are many small islands or chains of "islands," sparsely timbered, and sufficiently high not to be under water during the long rainy season. It is on these "islands," or *tesos,* as they are locally called, that the cattle congregate during the height of the inundations. On many of the more suitable of these tesos, are erected ranch houses, corrals and outposts. During the intermediate season, the pastureage over the campos is lush and ample, but later on when the campos is dry and parched by the equatorial sun, there is great suffering and mortality among the herds. On the other hand, during the flood time, there is also considerable loss of cattle, through mutilation by those bloodthirsty little man-eating fish, the *piranhas,* and by the thousands of *jacaré* (crocodile) with which the island fairly swarms.

This enormous eastern area of prairie lands is divided up into large tracts, or *fazendas* (ranches), chiefly owned by the more wealthy residents of Para. On one fazenda alone there are more than fifty thousand head of cattle, and it is upon these ranches that this important city of more than two hundred thousand inhabitants depends for its fresh meat supply. It might rightly be said, that these *fazendeiros* of Marajo, who own these huge tracts of wilderness, are the landed gentry of Para. And truly a wilderness it is, for one who enters the interior of this island without experienced guides, is certainly flirting with calamity, for he can become almost as helplessly lost as in the great forests that border the Amazon and its tributaries.

The cattle industry is carried on in Marajo on even more primitive lines than prevailed on our own western frontiers when the late Colonel Roosevelt spent his younger days on his ranch on the Little Missouri. Six-shooters, silver mounted saddles, dance-halls and horse rustling do not enter into the life of these island cowboys. Furthermore, the fact that for eight months of the year they are for much of the time mounted in canoes instead of in the saddles, deprives the picture of much of this former wildwest glamor. Their stirrups, on the other hand, add a unique interest, for they are but tiny rings only large enough to accommodate the great and perhaps the second toe. Their saddles are also peculiar sloping affairs, compared with which our army saddles are as soft and comfortable as a feather bed. Nevertheless, these cowboys of Marajo are able horsemen, skilled in all the arts of roping, bronco busting, steer riding and the rest. I attended more than one of their rodeos and roundups, and they were accompanied by a goodly quota of thrills and spills. If ordered to walk a couple of miles on foot their boss is a tyrant, but if dispatched on a fifty mile journey, they are in the saddle and off, to ride through the day and night through crocodile infested and insect swarming swamps as cheerfully and with less fear than our bank-runners making their appointed rounds.

Long before the discovery of America, the Island of Marajo was inhabited by tribes of



Dotted over the wide expanses of the open prairies are many small areas of higher ground, which are not subject to the annual inundations of the rainy season. Many of these areas or *tesos* as they are properly called, are thickly timbered, bordered by long sedgy grass, affording excellent cover for the jaguar. These powerful cats, including the rare black variety (simply a color phase) are found on Marajo in great numbers. The majority of jaguars that reach the zoos and menageries of the world are captured on this island.

aborigines whose origin and disappearance still remains but a mild speculation. Yes, before any white man had put foot on the soil of the Americas, these tribes had developed a high state of culture and then vanished from the face of the earth. All the evidence of their existence that is left to us are the mounds where they paid their last respects to their dead. Buried



The northeastern section of Marajo is practically open *campos*, ideal for grazing, and over this region roam more than a half-million wild and semi-wild cattle. Indian zebu bulls have been introduced among these herds and the infusion of this stock is quite noticeable in the character of the cattle bred from the alliance. It is upon these wild herds that the city of Para depends entirely for its supply of fresh meat.







The Marajo cowboys are most able horsemen, skilled in all the tricks of roping, bronco-busting and the rest of the arts which contribute to the thrills of a rodeo. For the most part they are descendants of former African slaves, and with few exceptions they are men of the most remarkable endurance and the perfection of physical development. The peculiar stirrups add unique interest, for they are small iron rings fastened to the stirrup strap, large enough to accommodate only the great toe and perhaps the second.



The municipality of Para maintains a small but interesting zoological garden. The authorities in charge have wisely limited the specimens to the more interesting examples of the fauna of the Amazon Basin. There is a very creditable synoptic collection of the more well known birds, mammals and reptiles of this rich faunal region.



Spider monkey, prehensile-tailed porcupine, and two-toed sloth in the market place. Para. Pará is a clearing house for every imaginable thing rare and commonplace peculiar to this land of river and jungle. Anything from the smallest parakeet, the savage jaguar, boas, anacondas, ocelots and huge turtles await the customer. Often these animals are shipped to Germany and then resold and shipped back to the United States. The jaguar Senor Lopez for many years in the collections of the Park was acquired by the Society in this manner.





Toucan is the native Brazilian name for this tropical American bird noted for its immense beak which gives it a rather grotesque appearance. By its size one might imagine that the bird would be burdened by so large an object, but the structure is a thin shell covering a spongy cellular mass within, and altogether of scarcely no weight at all. The plumages of the different species are combinations of delicate shades of blue, yellow, red and black, and the beaks of many are most fantastic in their color patterns. Besides soft pulpy fruits, the toucan is not averse to a regimen of eggs, fish, reptiles and small birds which are devoured entire; the bird giving the object a toss into the air whence it drops into his capacious maw. Here are two species, a young sulphur and white breasted toucan, (*Rhamphastos vittelinus*), and the red-billed (*R. monilis*).

in these mounds, archaeologists have found, in the form of most extraordinary ceramics, a clue, another link in a much broken chain, but the solution of whence they came, or the tragedy of their final extinction still remains a mystery.

There are but few collections of this remarkable pottery of varying forms, colors and design, in existence, and it was not only to study and photograph the bird and animal life of this island that lured me, but also to excavate for these archaeological treasures.

After a short stay in Para, I was able to organize an expedition to Marajo, and my party included a prominent Brazilian gentleman, who, together with other members of his family, owns several of the more important fazendas on the island.

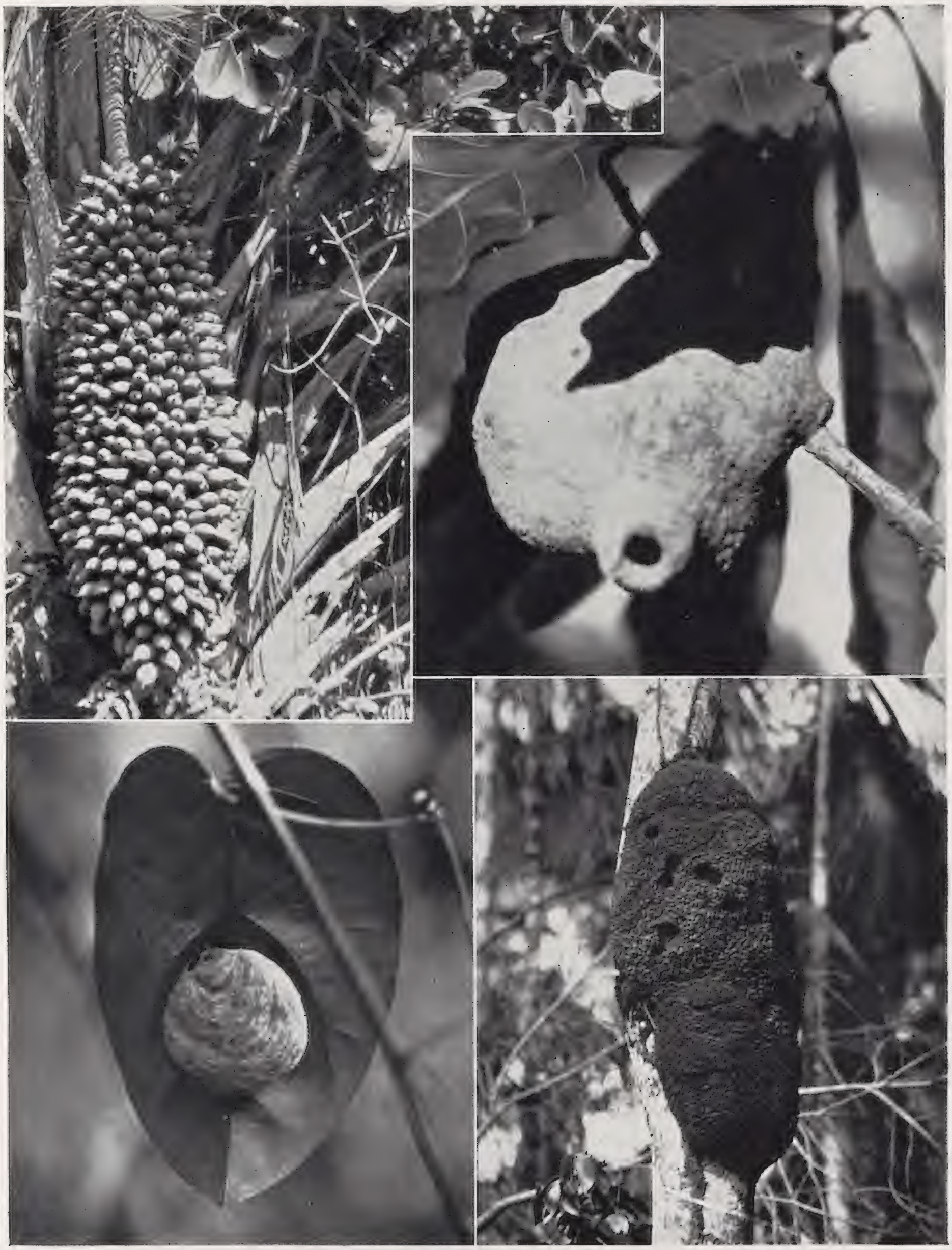
During these early days in Para, I spent considerable time rambling about the city looking for the unusual. Such ramblings naturally often led me to the Zoological Gardens, which though small in size, and also in collections considering the possibilities of securing specimens, comprises quite a creditable synoptic collection of the well known birds and animals of Amazonia. And while this collection is wisely limited to local material, I was particularly attracted by one exception, an adult female chimpanzee (*Pan niger*). This anthropoid had been confined there for many years, and was apparently enjoying unusual health and vigor. She was formerly the property of an American physician residing in Manaos, that remarkable isolated city one thousand miles up the Amazon. Her former owner, a specialist in tropical diseases, had imported two of these apes to Brazil from Africa, during an alarming outbreak of yellow fever, with the object of innoculating them with the germs of the disease, and then making exhaustive autopsies after death. One of the chimpanzees rapidly succumbed to yellow fever, but Olga, as she is called, not only refused to be laid low with this disease, but she showed equal resistence to other innoculations including many of the worst. After running the gamut of these injections, she was finally presented to the zoo at Para. I have had an opportunity to observe many chimpanzees, and I found Olga to exhibit a high degree of intelligence. One trait in her character was to me particularly interesting: If she got an object in her possession which interested her, its recovery was impossible except by offering her something in exchange which she regarded as more desirable. With one hand extended to receive the new treasure, the other hand containing the object already in her possession was kept out of reach. When the new treasure proffered was safely within her grasp, she never failed to fulfill her end of the bargain. Her keeper told me that before she had been deceived, "double-crossed" as it were, she had always been willing to pay in advance. However, after one lesson in the chicanery of mankind, she put everything on a strictly *C. O. D.* basis.

As is true in most far off places, I found Para's municipal market a spot of great and ever changing interest. It is the clearing house for every imaginable thing rare and commonplace peculiar to this land of river and jungles. Everything from the smallest parakeet to a snarling jaguar is offered for sale. One section is a diminutive menagerie. Boa constrictors and anacondas large and small; rare monkeys, parrots, toucans, and other smaller birds, to say nothing of giant ant-eaters, kinkajous, ocelots, huge turtles, and other strange jungle folk await the customer. Today many of these creatures are in this market, and tomorrow on their way to Germany to be shipped back over the broad Atlantic to be sold to zoos in the United States.

Flanking this market is the *Ver-o-pesa,* or municipal basin, the landing quay for most of the sailing craft trading at Para. The world traveler carries with him the memory of many unusual waterfront scenes. The canals of Venice, the dhows in the harbor of Mombasa, the junks on the Yang-tse, are lasting impressions. If his peregrinations lead him to the Amazon, this strangely fascinating scene of river life should certainly further enrich his retrospective archives. Into this basin, deeply indented in the city's wall, come with the early morning tide, picturesque craft and floating homes from the far and near interior. Laden with birds and animals and products of the wilderness, in they crowd beam to beam. With their colored sails of different hues, the flood of brilliant sunlight



The Municipal Market in Para is typical of similar places throughout Central and Tropical South America. It is the place of exchange and barter for everything indigenous to this rich and fertile land. These markets are open daily, but there are special days for the sales of fresh meats, vegetables and fruits and articles of wearing apparel and various textiles. Here may be found an exchange for the fauna and flora of the region both for domestic purposes and for delivery to the markets of foreign countries. It affords an ever changing scene of interest for tourist and scientist alike.



Oil nuts—*Upper left*—have created an important industry in Amazonia. Among the many oil nut bearing palms is the Babassu which is found in certain parts of Marajo; this is the land of the ant, there are hundreds of species, and their nests are both curious and interesting in structure. This species—*upper right*—has a home about the size of a peach which it skilfully conceals in the dense foliage of a tree. Frequently one finds such examples of bee architecture—*lower left*—cleverly attached to a leaf and so placed that it lies on the under side completely hidden. The nest is about the size of a quarter-dollar and makes a safe harboring place for its small stingless owners. This ant—*lower right*—is more ambitious and more powerful. The nest is about four feet long and is attached to a tree trunk about fifteen feet from the ground. The holes in the sides of the nest are the results of the onslaughts of arboreal ant-eaters and many species of ant-eating birds.



Close by the Municipal Market is the Ver-o-pesa, the municipal basin, the landing place for most of the craft which trade at Para. Into the basin, deeply indented in the city's wall, on the early morning tide, come picturesque river craft from far and near interior, with gaily colored sails of varied hues. Laden with the products of the wilderness, they crowd into the quay, beam to beam. Out of this labyrinth we hired a sturdy single-master—a rugged sloop, and when the evening brought the returning tide we slowly untangled from this Gordian maze of spars and sails, and got underway; a fair wind behind and hope of adventure ahead.

over it all, the effect might be compared to the tail of a giant peacock draped over a seemingly hopeless maze of hulls, spars and rigging. As the morning advances and the sun mounts in its daily midway course across the sky, the tide recedes rapidly and here in an ill-smelling, vulture-explored, black jelly-like ooze they lay through the long torrid day, a helpless tangled flotilla. As evening approaches, comes the returning tide. Then one may see them slowly untangle, and as the sun drops behind the Island of the Jaguars, silently they make their way, one by one disappearing like shadowy phantoms into the deepening blues of the brief twilight.

It was from this labyrinth, we were able to hire a sturdy single-master to make the voyage to Marajo. And so one August evening, shortly after sundown, with a native skipper and crew we were underway, a fair wind behind us and the hope of adventure ahead. There was an almost full moon, and the heavens were fairly alive with "shooting stars," which now and again cut pathways like tiny rockets among their neighbors. I soon swung my hammock between the stays, and lay enjoying the glories of the night. Astern rose the Southern Cross, lying obliquely like a mammoth diamond brooch, worn on a robe of purple mid countless distinguished gems. As I lay there enjoying the cool breeze, I could not but wonder whether my family at home pictured me sweltering in humid jungles, when as a matter of fact, within about one degree of the Equator I was covered with a warm blanket.

Such ponderings and dozings were soon to be rudely interrupted. Toward midnight, dark clouds driving across the moon, rumblings and flashes, followed by equally squally symptoms brought me out of my hammock and back from reveries. Our skipper, well versed in the treacheries of the Bay of Marajo, and these quickly formed storms, had shortened sail, and before the squall broke upon us in full force, we headed for and reached the shelter of a cove in the lee of a small island. Here we anchored, and then came the wind and rain, rain and more rain from which the cabin was the one refuge.

Now when ten men seek shelter in a cabin evidently designed to offer discomfort to about five, at the same time harboring odors of which bilge and forgotten fish are the mildest—well, I will leave my thoughts unrecorded. Fortunately the storm was soon over, but I shall always feel that I got a fair idea of what floated upward from the between-decks of the olden-day slave ships loaded with their human cargo.

With the passing of the storm we were again under way, and about two hours before daybreak we came to anchor off the mouth of the Rio Cambu, our point of entry to the island. Owing to the flat shelving beach, we were compelled to wait outside for the morning tide. With the dawn came one of the most marvelous pictures of bird life I have ever seen. Literally thousands and thousands of feathered fishermen came winging their way from the interior of Marajo to their feeding grounds along its coast. Long undulating lines of scarlet ibis (*Eudocimus ruber*) flying in "V" formations streaked like crimson streamers across the gray-blue sky, followed by countless hundreds of white herons (*Herodias egretta*) and *magoarys* (*Ardea cocoi*). Long wedge upon wedge of cormorants, (*Phalocrocorax vigua*) passed so low above my head that I could see their eyes, and the noise of their wings was like the wind whistling through the halyards of a ship. For nearly half an hour the air was alive with these different birds, while high above it all seven jabiru storks or *tuyuyus* (*Jabiru americanus*) to me the most inspiring of aviators, spiraled in wide circles. As I watched them through my binoculars, manipulating their ailerons, I was summoned back to earth by the voice of the skipper.

"Atire as guara, Senhor," he pleaded. *"Sao tao bons como gallinha."* (Shoot some scarlet-ibis. They are as good as chicken.)

I thought he was exaggerating when he made this claim for them, but keen appetites are never absent aboard ship, and while I expected them to be fishy in taste, to please the skipper and crew, I successfully dropped seven into the bay, and one of the men waded out and got them. I was surprised to find them quite good in flavor, and so we all enjoyed a hearty breakfast of roasted ibis. By seven o'clock there was ample water and we again dropped anchor a short distance inside the mouth of the Rio Cambu, and about a half mile from an outpost of one



We came to anchor off the mouth of the Rio Cambu a short time before daybreak. No more beautiful stream than this *igarapé* could be imagined. For miles it winds its silvery way through the *campos* of the island, but for the greater part it is hemmed in on either side by swamp and jungle. Lofty trees projected a graceful canopy of foliage over head, hosts of gaily colored flowers peeped through the luscious greenery and from the trees swept a maze of graceful tendrils like the streamers of a bridal wreath. Neither artisan nor artist could hope to achieve a glory of design to compare with this picture by the hand of the Creator.



Magoary, cocoi heron (*Ardea cocoi*) is found practically throughout South America. It resembles our great blue heron but the gray of the head and neck closely approaches white, forming a striking contrast with the darker portions of the plumage. From a photograph made in the Zoological Park.



The *jabiru* (*Jabiru mycteria*) is the largest of the three species of storks found in South America. The name is of native origin and is said to refer to the bird's habit of distending the loose skin of the neck. From a photograph made in the Zoological Park.



The pileated heron (*Pilerodius pileata*) is one of the most beautiful of its family. The body is pure white, set off by a crown of black, from which several pendent white plumes descend along the neck. The skin of the face is bare of feathers and bright blue in color. From a photograph made in the Zoological Park.



In the more open spaces, masses of bamboo and burity palms fringed the banks to the water's edge. I saw no fairies, but they must have been there, perhaps dancing behind the screen of trailing vines and feathery bamboos, to the lilting notes of the Sabias, whose plaintive, flute-like tones were so mindful of our northern woodthrush. On the high bank of the igarape was a nesting colony of *japims* (*Cassicus icteronotus*). These beautiful orange and black cassiques colonize near the habitations of man. Their curious gourd-like nests swinging from the branches shelter many birds, the females greatly out-numbering the males.

of the important fazendas, known as Camburupy. Here was a very comfortable two-roomed shack, which we could use as our headquarters at this point.

From a photographic standpoint, I was favored from the start. Only a short distance from the outpost and directly opposite a high bank of the *igarapé* (Tupi indian for canoe path) as these smaller rivers and streams are called, I discovered a large colony of *japims*. These beautiful orange and black cassiques (*Cassicus icteronotus*) seem to like to build their colonies near the habitations of man. They are most interesting and intelligent birds, and seem to be in full accord with the philosophy of Brigham Young, since they practice polygamy on a liberal scale, the females of these colonies always far outnumbering the males. They build long hanging nests, with a small entrance near the top, grouping their aerial apartments like a collection of well filled Christmas stockings. I set up my Akeley camera, and slipping in a telephoto lens, proceeded without shame to pry into their most intimate affairs. At first they seemed to view my actions with suspicion, scolding and apparently discussing the white man and his strange ways. In a short time, however, normalcy was restored and they settled down to their morning routine. The gregarious nature of these birds is shown in all their actions, particularly in feeding their young. The whole colony would leave the nests in a body, flying off into the nearby *matto* (jungle). Then everything would be quiet for a few minutes. Suddenly they would all return bringing jungle titbits for their young hopefuls, keeping up an incessant chatter and hubbub of strident calls. From early dawn until bedtime they carry on their garrulous gossiping, like so many housewives in a crowded tenement.

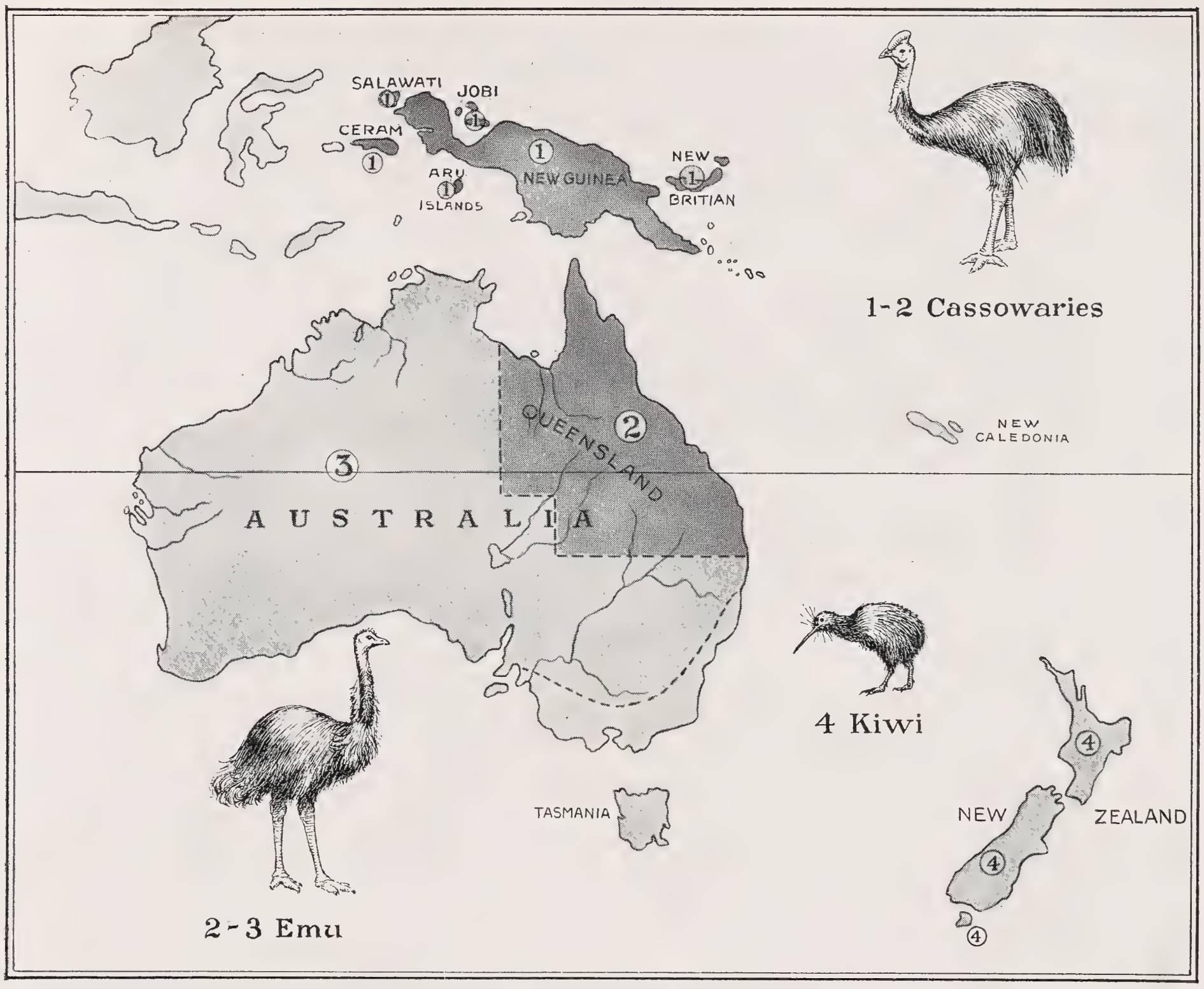
That same afternoon, I took a canoe and a boy to paddle, and made by first exploration of the Rio Cambu. I cannot imagine a more beautiful stream than this *igarapé* which winds its way through miles of this campos section of the island, but for the greater part, like most of the island's streams and rivers, hemmed in on either side by a wide fringe of swamp and jungle. In many of the reaches of the Cambu, lofty trees projected their branches in a bower overhead, festooned with air-roots, which in turn formed trellises for garlands of climbing plants. Interspersed among the lovely greens, burst forth the gaily painted blooms of the trumpet vines (*bignonidae*), while now and again a lovely orchid caught my eager eye. In many places both banks were lined with *mangue* and *ciri-uba* trees, their stilt like roots radiating in all directions. In the more open spaces, masses of bamboo and burity palms dominated the lower barriers of the stream. No man-designed effort of florist or artist could hope to approach the beauty and harmony of it all, and with almost every stroke of the paddle came something new to delight the eye.

Large crimson dragon-flies poised for a moment stationary against the blue, only the next instant to dart into some equally charming setting. Morphos, those vagrant princes of butterflies and bluer than any sky, languidly fluttered into the picture, and then vanished on their careless, aimless way. Now and again from the depths of the matta came the flute-like notes of the *sabias* (*Planesticus albiventris*) similar to the tones of their cousins, our northern woodthrush, while atop a high dead tree a solitary *cara-cara-y*, (*Polyborus tharus*) sounded his melancholy whistle. As we rounded one bend in the stream, five brilliant scarlet ibis had arranged themselves on a projecting limb in a framework of delicate foliage, the effect reminding me of a certain lovely Japanese screen I knew at home. Everywhere there were birds. Ibis, roseate spoonbills, boatbills, (*Cochlearius cochlearius*) white herons, magoarys, snowy egrets (*Leucophoyx candidissima*) and many varieties of kingfishers greeted us at every turn. They seemed but little disturbed by our invasion, only rising when we were almost upon them, while overhead flocks of parrots, (*Amazona amazonica*) made their noisy way through the tree tops. I saw no fairies, but I feel sure they must have been there, peeping out from the draperies of vines and bamboo, for in such a fairyland, surely there must be fairies.

Concluded, September-October Bulletin



The boat-billed heron (*Cochlearius cochlearius*) derives its name from the extreme breadth and thickness of its beak. The eyes are very large, doubtless an adaptation to the bird's nocturnal habits.



Sketch-map showing the distribution of the Cassowaries, Emus and Kiwis. It is intended to give a general idea, only, of the lands where these birds live.

The Struthious Birds

Part I. The Emus, Cassowaries and Kiwis

LEE S. CRANDALL

Curator of Birds, Zoological Park

The illustrations are from photographs made in the Zoological Park unless otherwise noted.

BECAUSE of their great size, and a common inability to fly, the ostriches, rheas, cassowaries and emus fall into a natural group, which, until within recent years, has received scientific sanction. Extended study has now caused most investigators to feel that the superficial resemblances between these birds are, for the most part, examples of parallel development, rather than expressions of actual close relationship. They are usually assigned to four Orders: Rheiformes, or Rheas; Struthioniformes, or Ostriches; and Casuariiformes, which includes both the Cassowaries and the Emus. A fourth species of Apteryx, or Kiwi, of New Zealand. These four Orders come under the Sub-class Ratitae, collectively known as the struthious or ostrich-like birds.

The ancestors of these great birds must have sprung from far down on the avian stem, for the forms of the present day still retain certain reptilian characters. The most prominent of these are the claws which persist on the digits of the wings—three in the Ostrich, two in the Rhea and one in the Cassowary, Emu and Kiwi. These and various other primitive left-overs, coupled with the reduced size and functionless Order, Apterygiiformes, is formed by the various

condition of the wings, led early observers to consider the struthious birds as little better than feathered reptiles, which had failed to progress to the flying stage. At the present time, they are looked upon rather as the descendants of forebears capable of flight—fallen angels, in fact, that have renounced the freedom of the skies to live on earth.

The degeneration of the wing has been balanced by adaptation of the legs to running at great speed, at least in those species which rely on them chiefly in escaping their enemies. The Ostrich, Rhea and Emu are dwellers on open or lightly wooded plains, and all are swift of foot. The toes of the Ostrich have been reduced to two on each foot, while the Rhea and Emu have three. The Cassowary, evidently somewhat closely related to the Emu, has the same number of toes, but its legs are short and thick, and it relies on the protection of the thick bush and a powerful kick, rather than on high speed. The little Kiwi possesses the normal four toes of birds in general, and seeks to avoid discovery by skulking, nocturnal habits.

The Emus are open country birds, and range over practically the whole of Australia. Several forms, apparently of doubtful value, have been described. In common with the Cassowaries, they differ from the Ostriches and Rheas in the character of the plumage, the feathers being long, narrow and almost hair-like. They also have the appearance of being double, the after-shaft being so developed that it nearly equals the main feather in size.

The curious nesting habits of the Emus are well known and accounts of their breeding in the Zoological Park have appeared at various times in our Bulletin. Incubation of the eggs and rearing of the young are accomplished by the male alone, the female bearing no part once the eggs have been laid. This reversion of the parental instinct is also found in the Rhea and Kiwi, and probably in the Cassowary as well, although in the latter case, the facts are not well known.



Secondary feather—*upper*—from the wing of the South American Condor. The units that compose the structure of the wing are perfectly joined, giving the necessary air resistance when the bird is in flight. Body feather—*lower*—of the Emu. In all of the struthious birds, the tiny hooklets or barbicels that join to make the firm surface of the feathers of birds of flight, are degenerate or altogether lacking. The result is a soft, delicate plume, with no resisting surface. The double effect in the Emus and Cassowaries is caused by the unusual development of the after-shaft



Left—*upper*—feet of Emu; *middle*—feet of Cassowary; *lower*—feet of Kiwi. The Emu has three toes only, the hind toe having been abandoned as detrimental to speed. The Cassowary also has but three toes, with the inner digit of each foot armed with a greatly elongated claw. The Kiwi still retains the hind toe or hallux, since it depends on skulking habits rather than on speed to escape its enemies. Right—*upper*—Head of Emu; *middle*—head of Cassowary; *lower*—head of Kiwi. The head and neck of the Emu are fully, though thinly, feathered, with a curly tuft on the crown. The Cassowary wears a bony helmet as a protection against the branches and thorns amongst which it is constantly barging its way. The head and much of the neck are bare. the skin being brilliantly colored. In the Kiwi, the base of the beak is surrounded by a number of highly specialized, hairlike feathers which act as feelers.



A flock of sub-adult Emus, from which one of our breeding pairs was derived. The late Keeper George Snyder, who was mainly responsible for our success with this species is seen fondling one of the birds.



Feathers of the Cassowary and Emu photographed to show the similarity of form and the differences in the textures of the barbules. *a*, feathers of Emu. *b*, feathers of Cassowary.

In the more settled districts of Australia, particularly along the eastern and southern coasts, the Emus have been nearly exterminated but in the wild, undeveloped interior of the country, they continue to thrive and undoubtedly will do so for many years to come.

The Cassowaries are the only members of the group of struthious birds that have become adapted to life in the jungle. Their heads are protected from thorns by a heavy casque, and their short, powerful legs are fitted for crashing through tangled bush, rather than for dashing at high speed over open plains. The bare portions of the face, as well as a long, narrow space on each side of the neck, are brightly colored, in blue, red and yellow, the variations in shading being an important factor in the separation of forms. About twenty have been described, ranging from northeastern Australia to New Guinea and small adjacent islands.

The plumage of the Cassowary is much like that of the Emu, having the same well-developed aftershaft. In structure, however, the wing is quite different from those of other struthious birds, the flight feathers being represented by five or six hard, stiff quills. The function of these appendages is not understood, but I have seen an enraged Cassowary scrape his wing quills along a fence, making a loud, rattling sound, which may be the key to the mystery.



Although wild Emus never see snow even in the most southerly parts of their range, our birds enjoy it immensely, leaping and kicking to show their pleasure. This is our original breeding pair. The female was secured in 1911, the male in 1913. Both are still living.



In the Emu, incubation of the eggs and care of the young are left to the male alone. The eggs are laid in midwinter, and since the incubation period is eight weeks, the chicks are hatched in March or early April. This brood of five is enjoying an outing in the first chilly sunshine of spring.



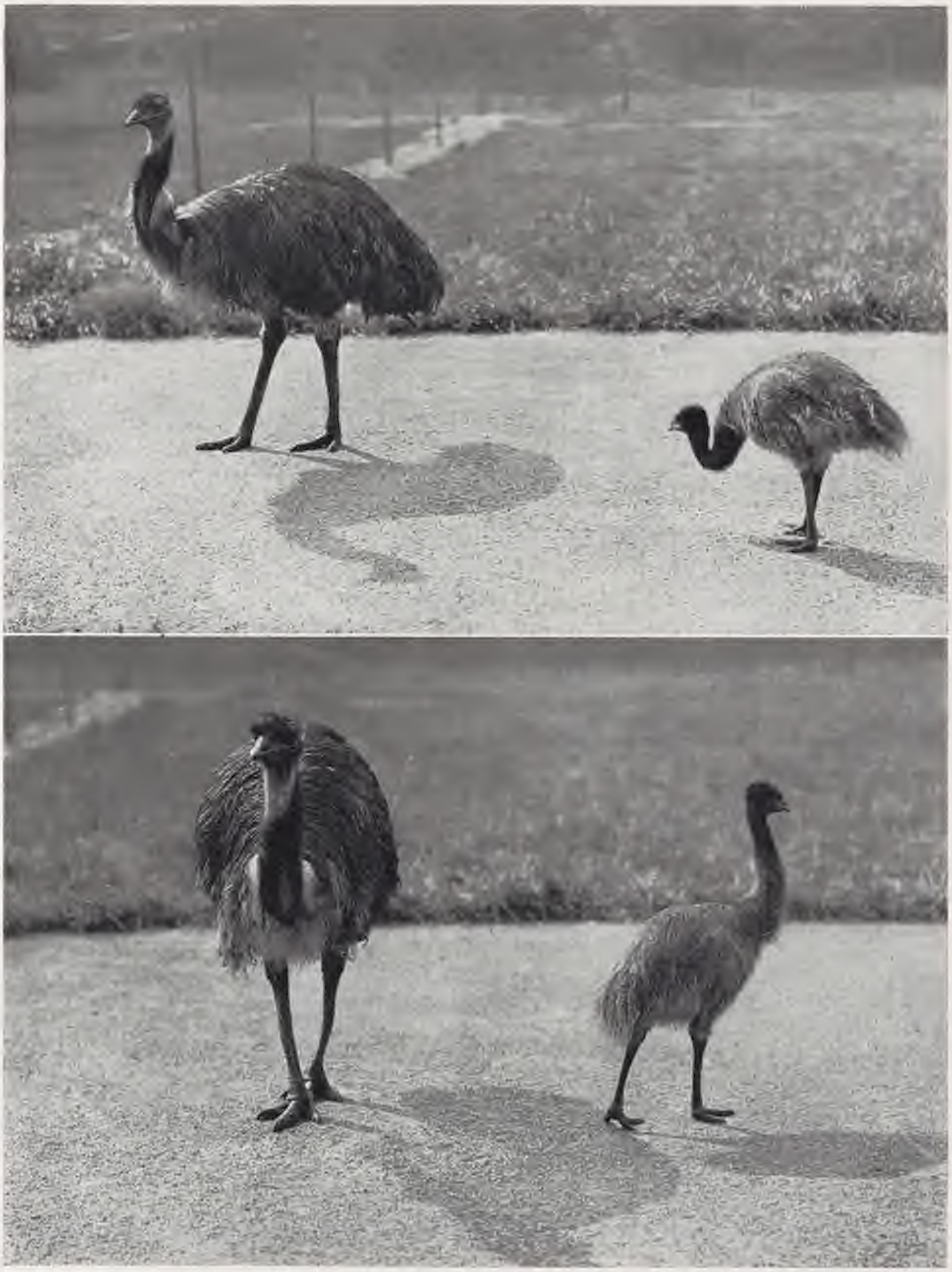
The same brood in midsummer, with the male bird still in charge. The young birds are between three and four months old.



Upper-left—An Emu egg, showing the shell chipped by the imprisoned chick. *Upper-right*—Newly hatched Emu chick. *Lower*—Emu, male parent, with a week-old chick.



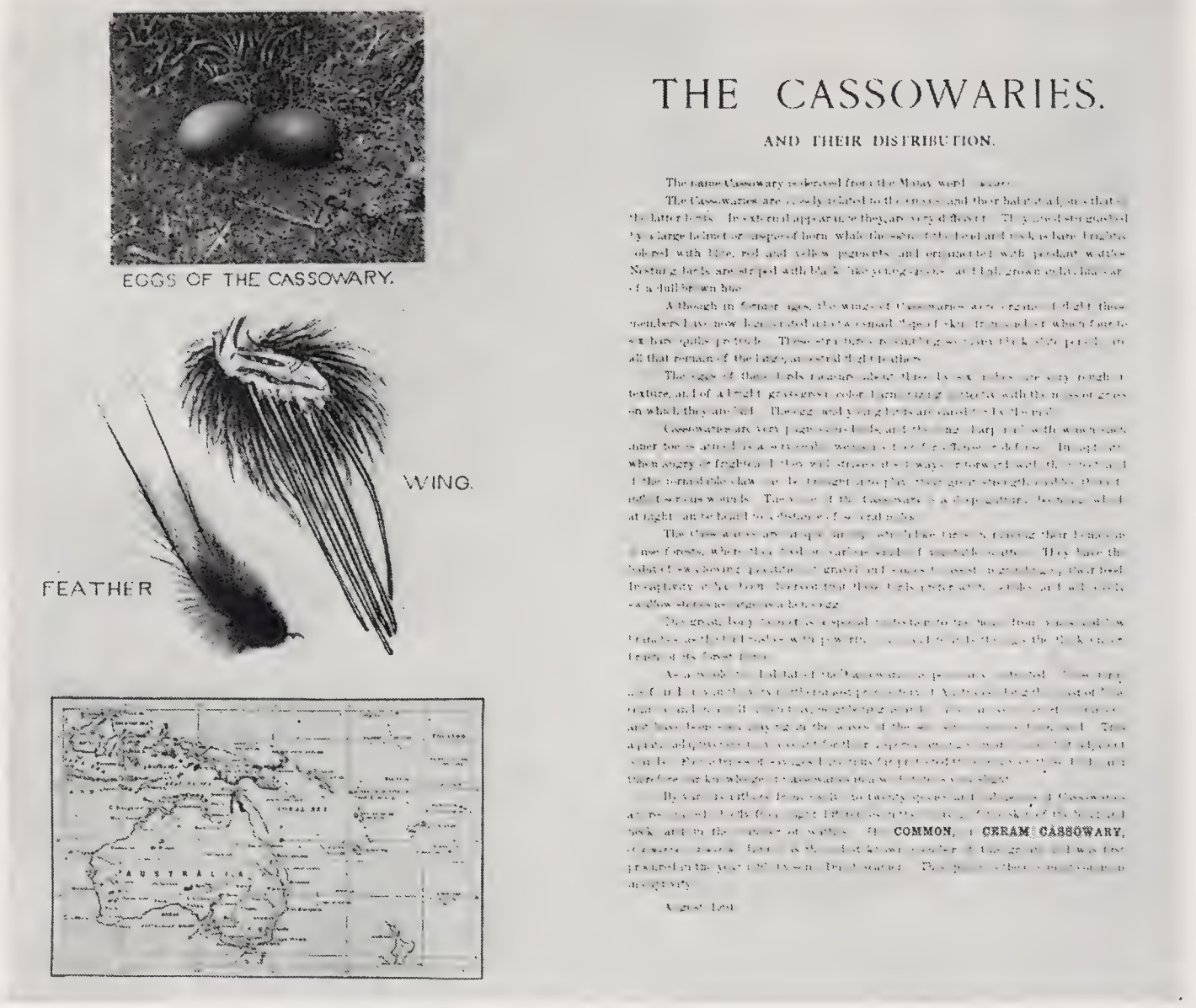
Upper—Emu chick, about three weeks old. *Lower*—Emu chick, about four weeks old.



Upper—Emu chick, three months old. *Lower*—Emu chick, about four months old.



Upper—Emu chick, about six months old. *Lower*—Emu chick, about eight months old, fully feathered but still slim of body.



Cassowaries are fierce, pugnacious creatures, able and ever willing to deliver stunning blows with their powerful feet. Wounded birds are treated with respect by natives in the bush and captive specimens receive watchful consideration from their keepers.

The Kiwis are by far the smallest of the struthious birds, most of the species being about the size of a large domestic fowl. They are further characterized by a long, slender beak and wings so tiny that they are hidden by the hair-like body plumage. The Kiwis are largely nocturnal, and frequent tangled bush and grass country, where they use their sensitive beaks in probing for the earth worms that form the bulk of their food. Their legs are very stout in proportion to the size of their bodies, and are able



Upper—Typical descriptive label, as used in the Ostrich House in the Zoological Park. *Lower*—Wing of Cassowary, showing the curious quills that represent the flight feathers.



The Ceram Cassowary (*Casuarius casuarius*) inhabits the island of Ceram, which lies to the west of New Guinea. It is sometimes known as the "common" Cassowary.

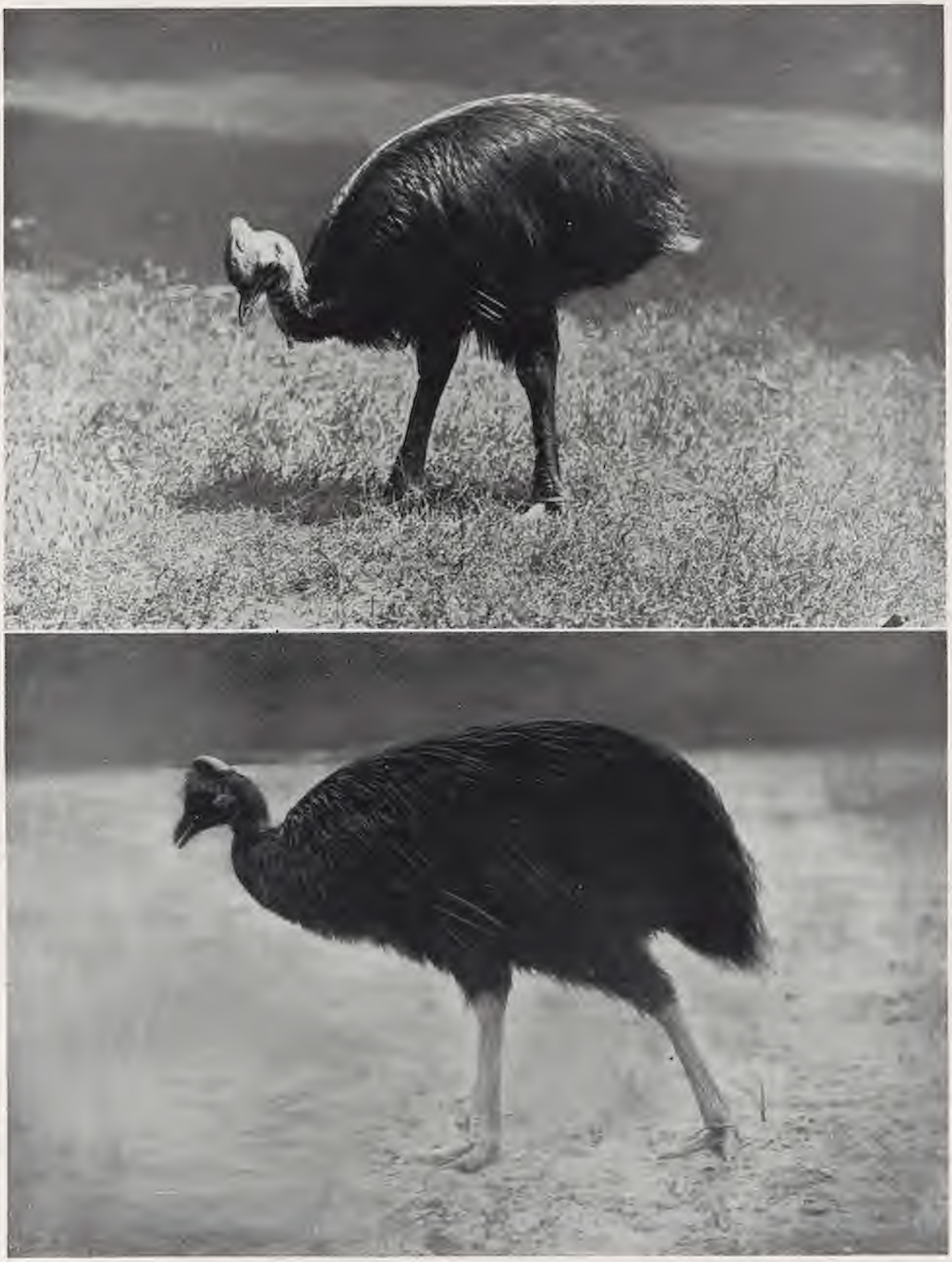




This plate, showing the head of the Ceram Cassowary, has been reproduced from Lord Rothchild's "Monograph of the Genus Casuarius." It shows clearly the characteristic form of the casque, in this species, the bare tracts of the head and neck and the two pendant wattles on the throat, which are highly colored in the living bird. *Lower*—An immature One-wattled Cassowary (*Casarius unappendiculatus unappendiculatus*).In the adult, the casque is three-cornered.



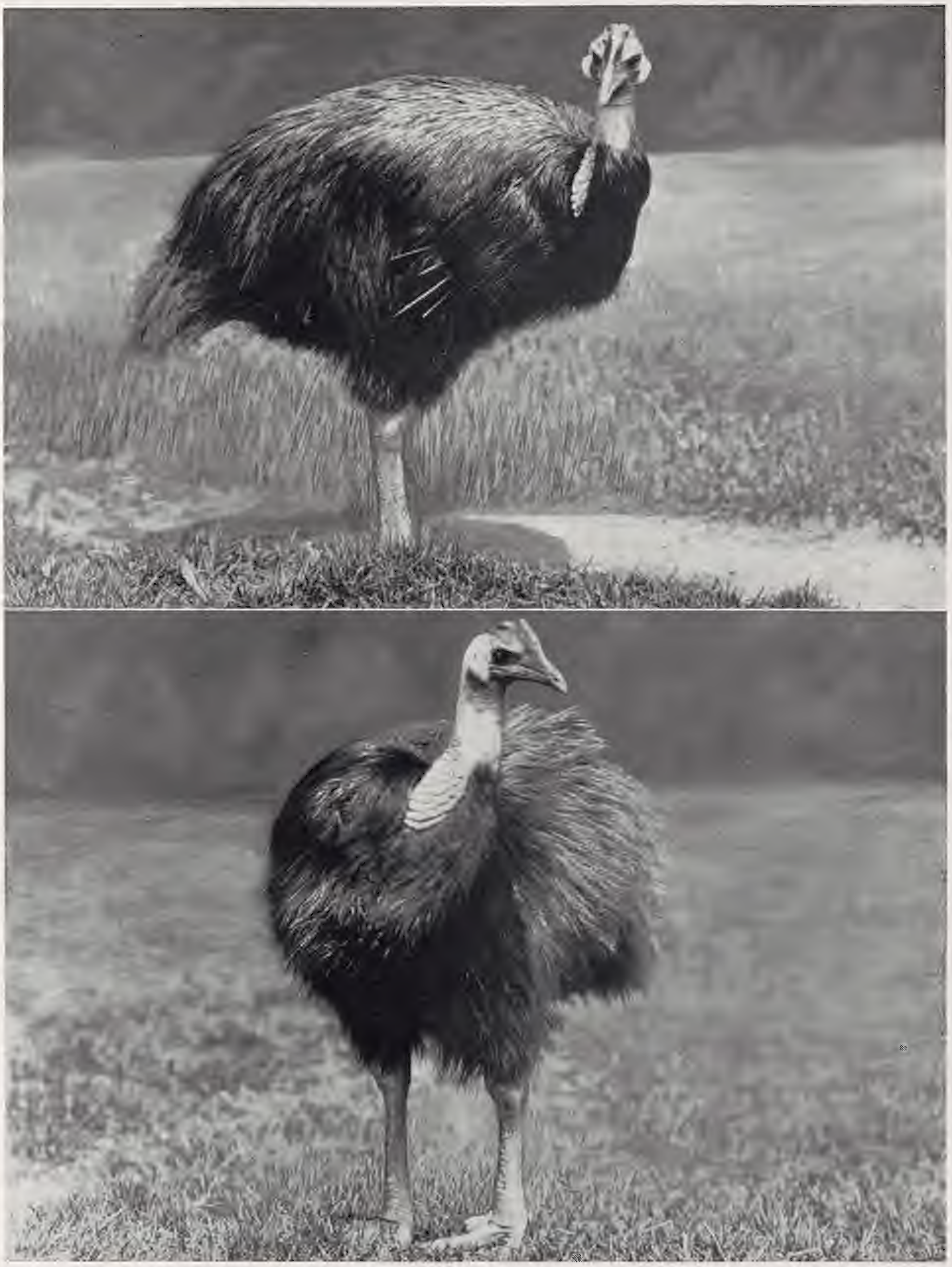
Immature Jobi One-wattled Cassowary (*Casuarius unappendiculatus occipitalis*) from the little island of Jobi, which lies just north of New Guinea.



Upper—Fully adult Jobi One-wattled Cassowary, showing the high, narrow casque characteristic of this form. *Lower*—Bennett Cassowary (*Casuarius bennetti*), from New Britain, where it is known as the "Mooruk." The head coloring is dull and there are no wattles on the fore neck.



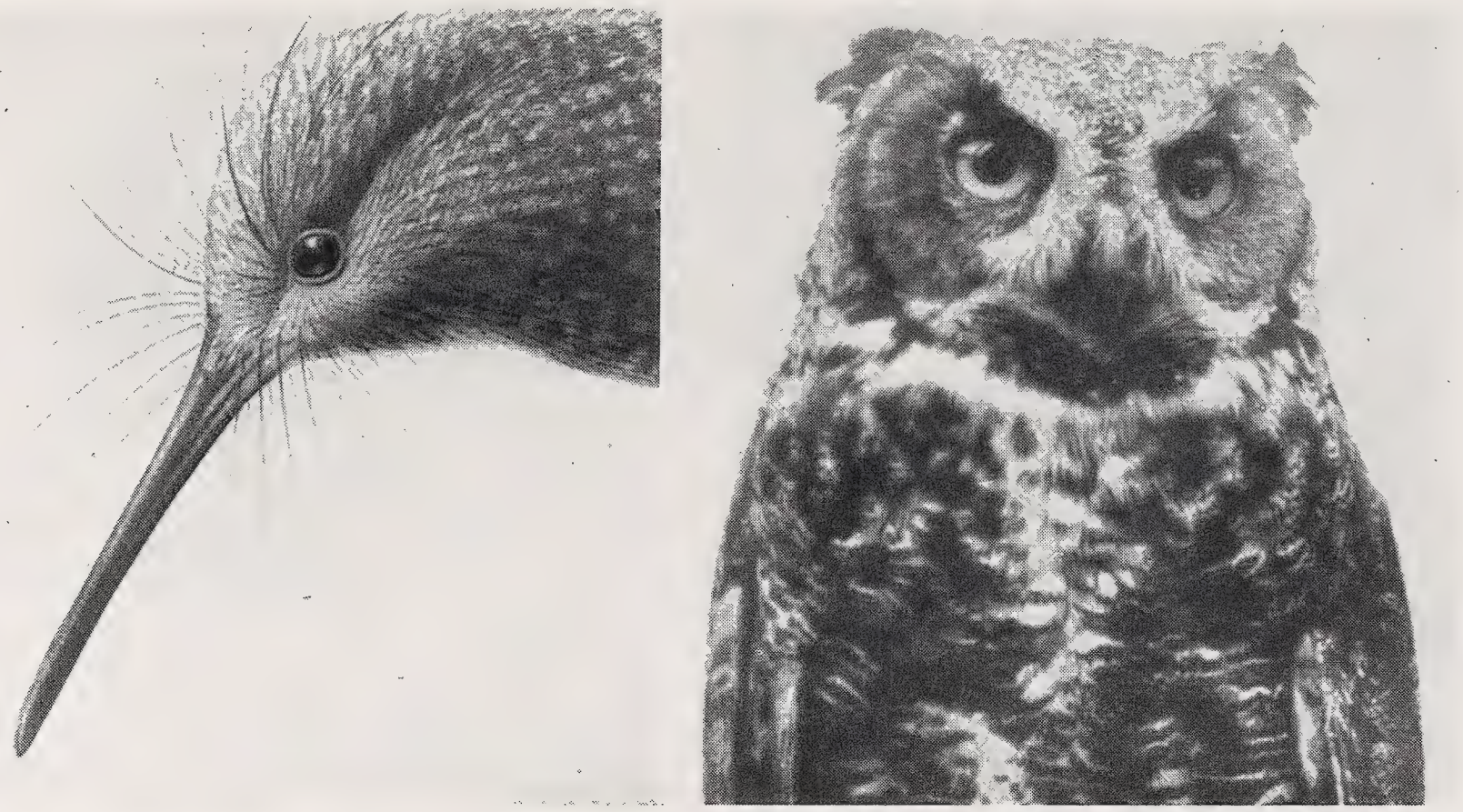
Two young specimens of the D'Albertis Cassowary (*Casuarius casuarius sclateri*). This is the common cassowary of the coastal regions of southeastern New Guinea.



Two poses of the Papuan Cassowary (*Casuarius papuanus*), from northwestern New Guinea. This is one of the smallest species. It is further characterized by having the nape pure white and the neck wattle represented by a mere button.



The Kiwi (*Apteryx*) is much the smallest of the struthious birds. It is found only in the islands of New Zealand, where it is represented by six species, none much larger than a domestic fowl. Unlike the larger members of the group, the Kiwi depends for protection almost entirely upon thick undergrowth. It usually remains hidden during the hours of daylight, coming forth at evening to probe with its long beak for earthworms. Photograph of a mounted specimen in the American Museum.



Left—Head of Kiwi; *right*—Head of Great Horned Owl. Striking examples of adaptation to nocturnal habits, each bird attaining its object in its own way. In the owl, the eyes are very large, and make the most of the faintest rays of light. They are further assisted by well developed ears. The eyes of the Kiwi are very small, hardly more than beads, but the loss is amply balanced by the hair-like feathers which extend from the face near the base of the beak, and by the delicate, highly sensitive beak.

to deliver the vigorous kicks for which the entire group is noted.

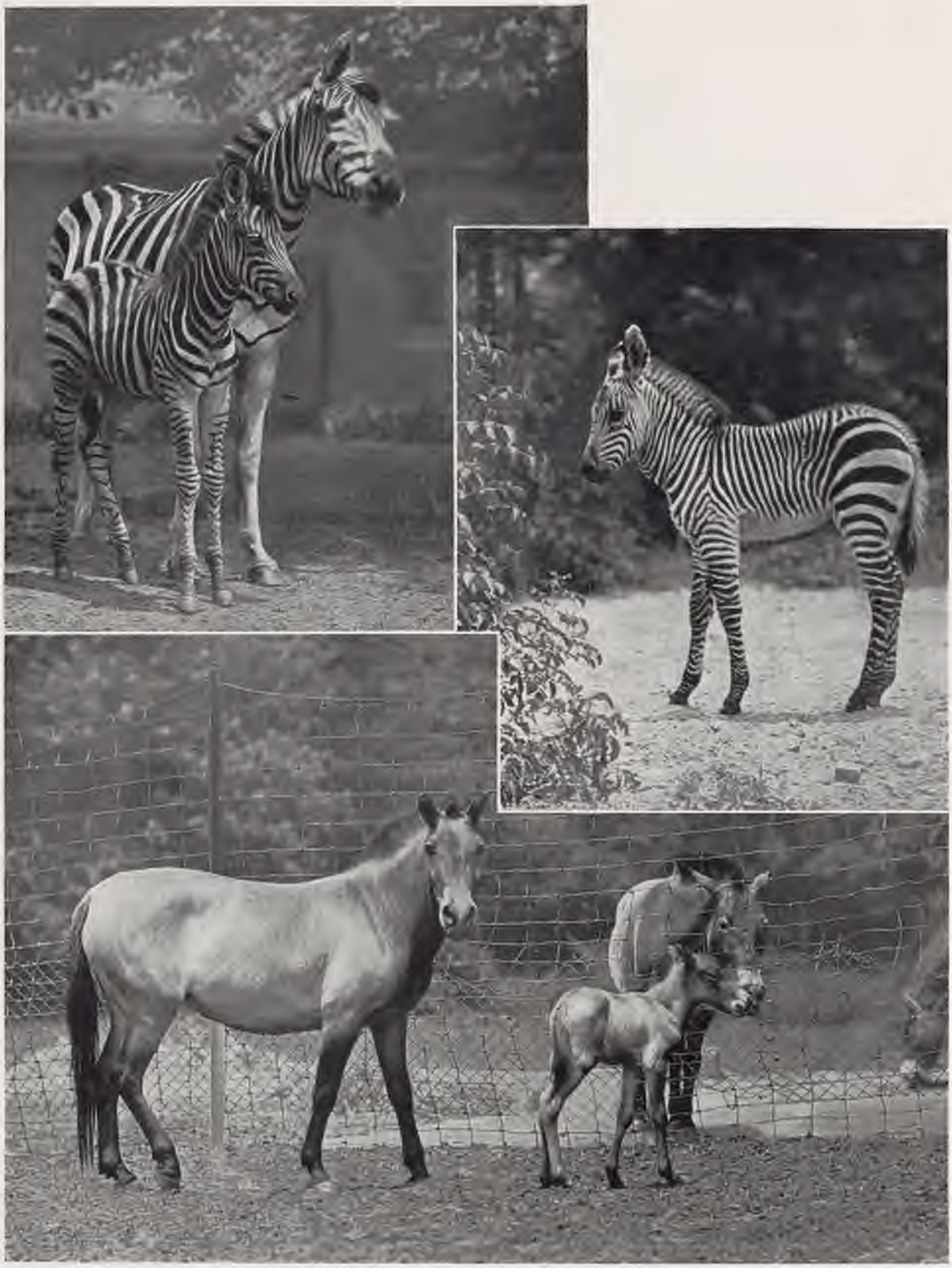
The breeding habits of the Kiwis are peculiar, the female excavating a burrow, in which she lays two white eggs and apparently leaves them in the care of her mate.

Dogs and men have reduced the Kiwis practically to extinction, although efforts have been made to preserve them in Government sanctuaries. Six species are recognized, all confined to the various islands of New Zealand.

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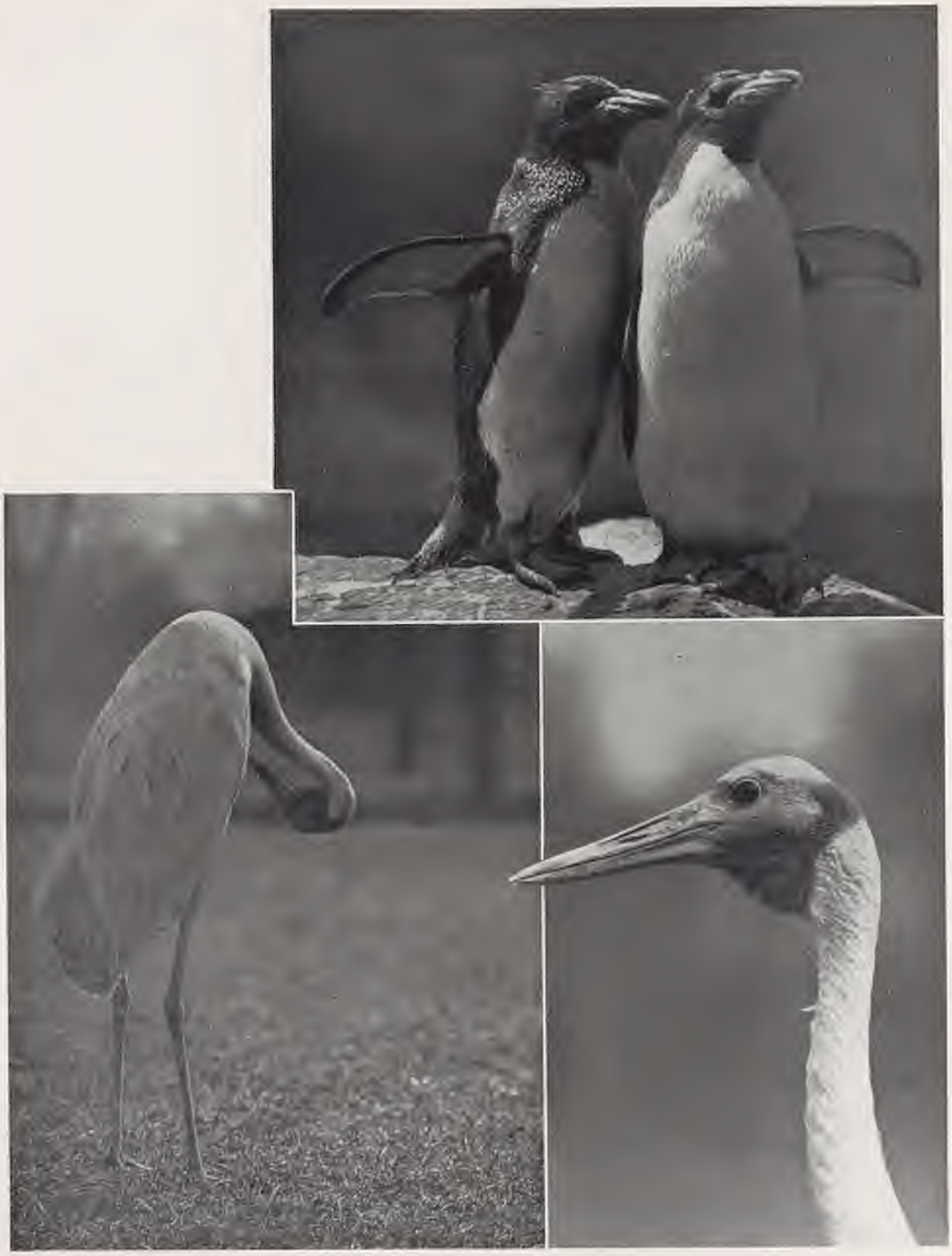
North Island Kiwi, from an old lithograph.



The collections of the Zebra House have been increased this year by the births of a Chapman Zebra, (*Equus chapmani*), May 5, 1929, and a Mountain Zebra, (*Equus zebra*), May 26, 1929. Both of these species have proved good breeders. The pair of Prjevalsky horses (*Equus prjevalskii*), originally acquired through an expedition financed by the Society and carried out through the Hagenbecks have prospered and their progeny still flourish. This young colt was born in 1929. Further information concerning the zebras may be found in the Bulletin for July-August, 1926.



The Greater Kudu (*Strepsiceros strepsiceros*)—*upper*—is a young male specimen recently acquired by the Society. This interesting antelope of the Family *Bovidae*, sub-family *Antilopinae* when fully grown bears long spirally twisted horns and it is marked by narrow white stripes on the sides of the body descending from a similar stripe along the back. The female kudu is distinguished by the absence of horns. The generic name *Strepsiceros* is from two Greek words meaning "twisting horns." The head of the common Iguana (*Iguana tuberculata*) would serve admirably as a model for legendary dragons.



The penguin is a bird to excite the imagination of the most casual observer. Web-footed, flightless with flipper-like wings, legs placed far back, plantigrade feet to enable the bird to sit firmly erect, without quills in the wings and feathers like scales, the penguin is neither fish nor fowl. On the land he is awkward and clumsy; in the sea he is transformed. His anatomical make-up is designed to offer as trifling resistance to the water as the smooth sides of a submarine. He is a living torpedo of graceful speed, flying under the sea as swiftly as a bird in the air. The two penguins shown here are the Golden-crested (*Eudyptes chrysolophus*) called by sailors rock-hoppers and maccaroni. The Australian Crane (*Mathewsia rubicunda*) —*lower*—is found on the great plains of the interior Australia. Its erect, almost human posture, makes it a favorite with lonely sheep-herders who know it as the "native companion."





Two principal species of the lynx are found in North America, the Canada Lynx (*Lynx canadensis*) and the Bay Lynx (*Lynx rufus*), also called Red Lynx, Wild Cat or Bob Cat in different localities. This specimen is the Bay Lynx. The lynx is not regarded as a dangerous animal except when brought to a stand. It is heavily furred and distinguished by a short, stumpy tail. A strictly carnivorous animal feeding chiefly on small ground-dwelling game and occasionally birds.

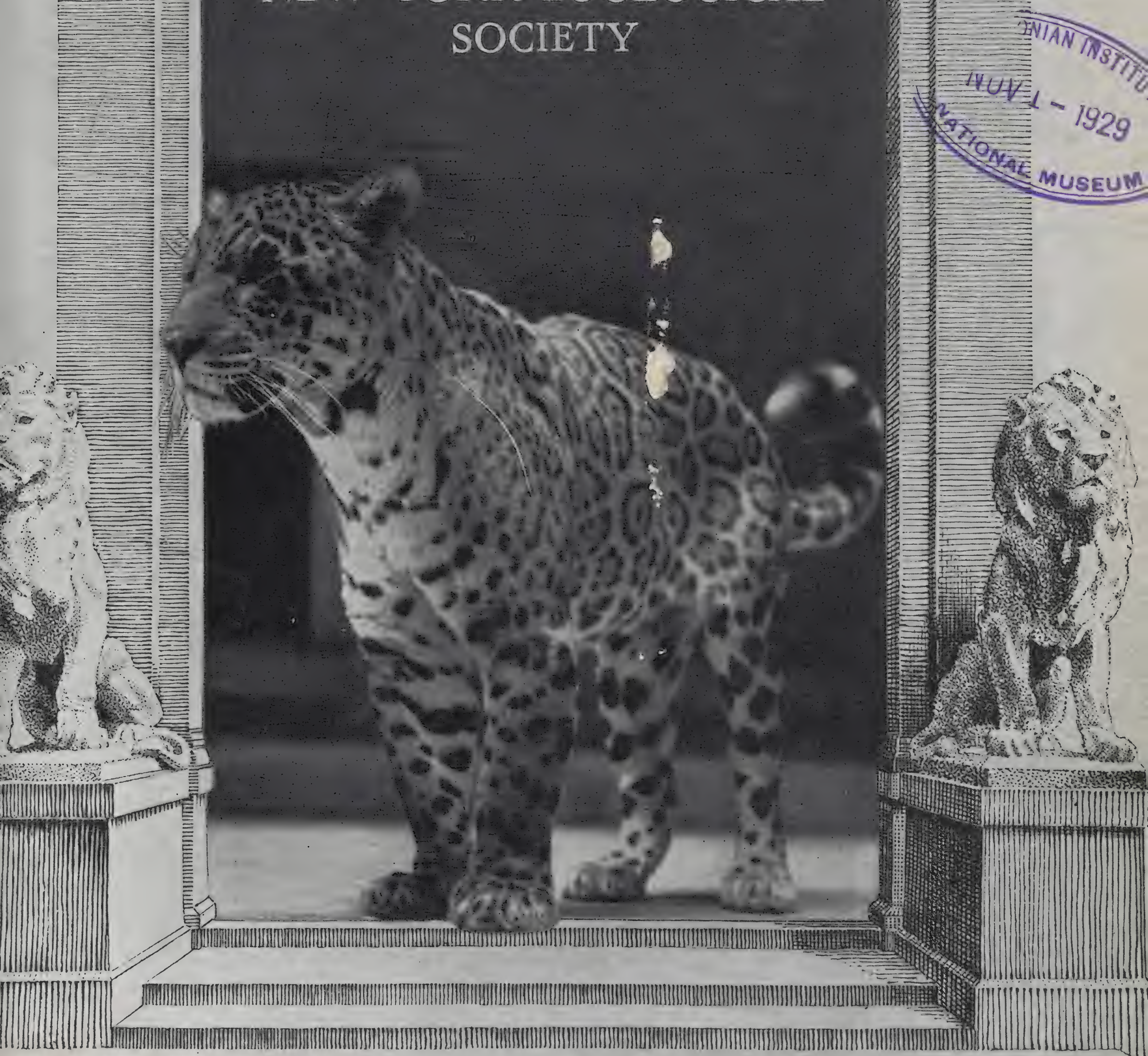
The Giraffe of the Family (*Giraffidaei*) is an African mammal of the Order *Ungulata,* and the tallest of living mammals; a full grown male attaining a height of sixteen feet. It is characterized by horn-like appendages on the heads of both sexes which are developed before birth. It is a timid animal depending on its highly developed vision to detect enemies and speed to distance them. This young specimen, is a Nubian Giraffe (*Giraffa camelopardalis*) born in the Park in January 1929.



Of the several interesting species of wild geese indigenous to the continent of North America, none is so well known as the Canada goose (*Branta canadensis*). Of its mating habits, there is a pretty legend of the fidelity of the pair, the bond being severed by death only—a constancy unquestionably more common among animals than man. But of its protection and care of the young fledglings there can be no doubt: it is an example of tenderness and devotion that might well be adopted by most humans. When the signal for the southland flight comes upon the wings of approaching winter, and the great flocks rise to the trumpet note of the leader, what manner of man is he who is not thrilled by the majesty of this mysterious call of the wild.

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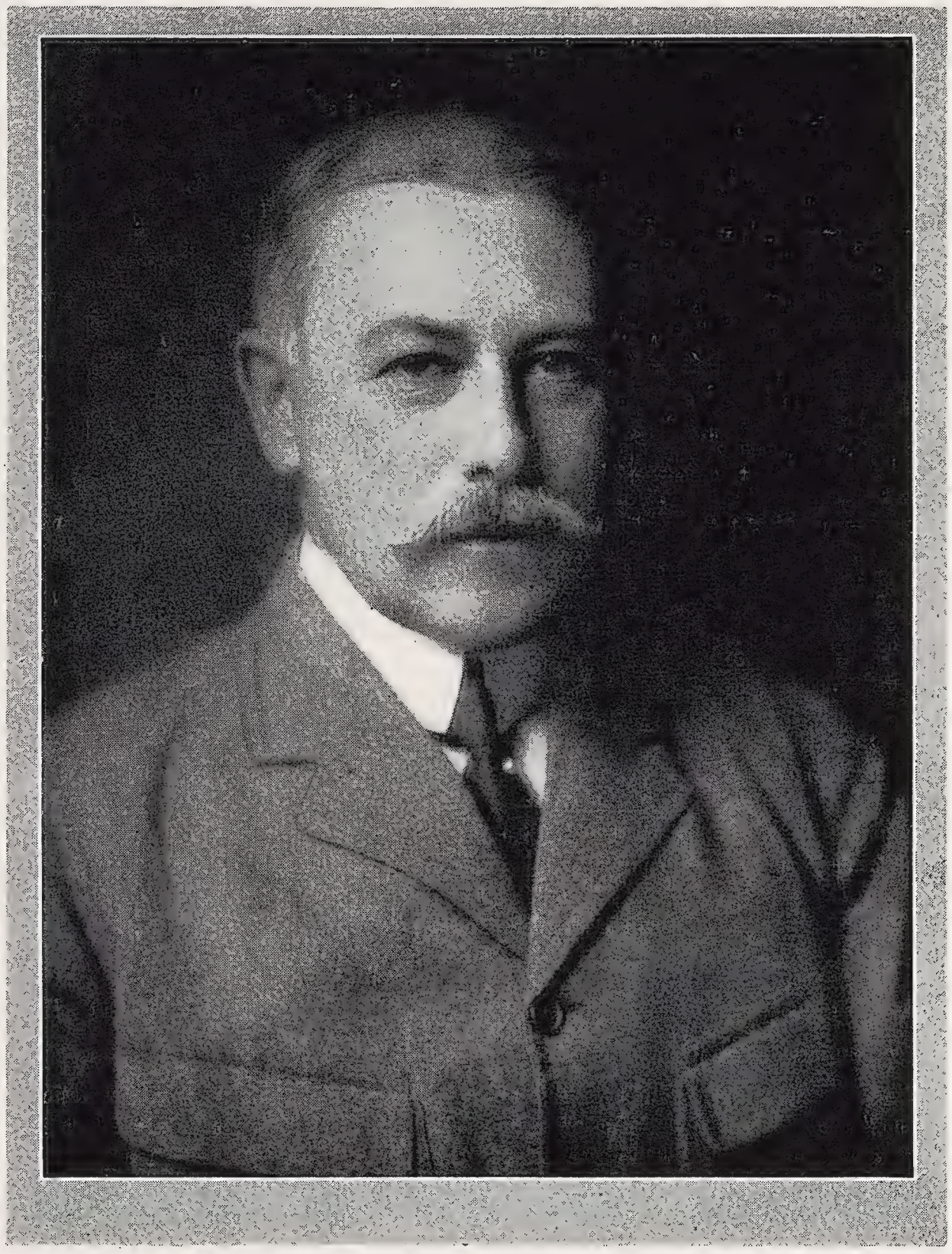
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1857—1929

PERCY RIVINGTON PYNE was one of that small but distinguished group of men who organized and made possible the New York Zoological Park and later the development of the New York Aquarium.

Mr. Pyne had been a member of the Board of Managers and the Executive Committee since the organization of the Society. He was devoted to the best interests of the Zoological Park and gave freely of his time and money in order that it should come to occupy a worthy place among the many notable scientific, educational and recreational institutions of this City.

He was a man of excellent judgment, extreme modesty, perfect poise and unselfish generosity. His passing is a great loss, not only to the Zoological Society, but to numerous other institutions to which he gave such devoted and distinguished services.

W. R. B.

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Marajo, Wonder Island of Amazonia

Part II. Review of the fauna, modes of travel and quest for archaeological treasures.

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Illustrated from photographs by the author unless otherwise noted.

A FEW days after my first reconnaissance of this charming little river, I worked my way farther up stream, and came upon what may possibly be the largest colony of white herons, (*Herodias egretta*) in Brazil. Before I was within half a mile of this colony, I could hear the uproar of the *garças* (their local name) at their nests. When we came abreast of the colony, the tremendous din of their raucous voices was really amazing. Their breeding grounds covered an area of several acres, while the number of nests and birds almost defied anything but a rough approximation. So numerous were the adult birds, that the tall trees looked as though they were in full bloom with huge white flowers, and hundreds that had not yet developed their flight feathers, awkwardly stalked about on the ground. Constantly I would hear the dull thud of some unfortunate fledgling that had fallen or been crowded out of its nest. I saw dozens of these youngsters killed in this way during a few hours, yet it seemed as though they could not possibly be missed in the confusion and bedlam of the mob overhead. Several *urubus,* (black vultures) were in constant attendance on the colony, and no sooner was the sound of such an unfortunate's fall heard, than one of these horrid looking birds would be on hand to seize the victim. They always reminded me of a lot of ghoulish imps of darkness, perched about in hopes that tragedy would bring them fortune. While undoubtedly this type of raptore has its place in the scheme of the cosmos, I must admit to wantonly burning up many a shell on these hideous flying mortuaries, nor have I ever regretted the cost of the cartridges. Anyone who has ever watched them in the streets of South American cities and about the abattoirs, I think will share my feelings toward them.

At this colony I was quick to notice the absence of undergrowth beneath the giant mangue and ciri-uba trees that made up the grove. Upon inquiry I found that the ground under the nests was kept clear in order that the aigrettes shed by the birds during the breeding season could readily be gathered up for market. This heronry is kept protected by the owners of the land, and a watchman is always present during this period to guard against plume poachers. It is only during the breeding season that the egrets develop the plumes so eagerly sought for millinery purposes. At this and one other colony in Marajo, none of the garças is killed for the aigrettes—only the shed plumes being taken. These are



The rivers and streams of Marajo have no real sources, and therefore no downward current. They fill and empty with the tides. The fish-trap shown in the foreground is covered at high tide, which shows how great is this rise and fall, some fifteen to eighteen feet.

sent to Para where they are cleaned and sold in Brazil and those countries where so far there is no taboo on trading commercially in the feathers of plumage birds. It is hoped that Brazil will soon join the list of the countries so wisely allied in the movement for bird conservation.

I spent many days in photographing and studying this wonderful city of herons. Just adjoining this heronry was a large colony of cormorants where I was also able to get a fine series of motion picture studies. Under a small dead tree in this latter bird community, I was quite surprised to find a considerable pile of snail shells of the genus *Ampullaria.* I had frequently noticed these shells on the open campos, in fact had collected several specimens for Dr. Pilbry of the Philadelphia Academy, but the one under this tree had evidently been dropped from above. While I was speculating whence they came, the solution of the problem alighted in a nearby tree—a *gavião de urua,* (*Rosthramus leucopygus*). These interesting hawks are quite plentiful in the Lower Amazon, and have an elongated hook on the upper mandible, something after the order of the Kea, the sheep-killing parrot of New Zealand. I had heard that these hawks fed on snails, using their hooked beaks to tear *Ampullaria* from his portable fortress, and now the evidence was before me.

These smaller rivers or igarapés, such as the Rio Cambu, have no real sources, and therefore no real downward current. This is true of all the streams that lead into the estuary of the Rio Para. They depend entirely on the ebb and flow of the tide, emptying rapidly with a swift current and a drop of perhaps fifteen or more feet. In one of the illustrations will be seen a typical bamboo fish trap, and the great rise and fall of these streams can readily be imagined by the fact that these traps are but a few inches above water at high tide.

After a few pleasant days on the Cambu,



Under the ciri-ubu trees that made up the grove of the rookery there was an entire absence of undergrowth. The space is kept cleared so that the shed plumes could be gathered.

word came from the main fazenda of Camburupy, that a large jaguar (*Felis onça*) had killed a colt the night before, and had been tracked to a teso not far distant. This news seemed to me to spell promise of good sport, and at my request a man was dispatched to get word to the *caçador*, (hunter) to delay the pursuit of the jaguar until we arrived. Jaguars, including many of the black phase, are quite numerous in certain sections of Marajo, and some of the fazendas have one or more experienced hunters. Few of these *onças* are killed with firearms, in fact, there are few rifles owned on the island suitable for such dangerous game. The native method of killing them is both primitive and attended with considerable skill and bravery. These hunters go armed with long spears, on the ends of which are attached double-pointed irons something like a diminutive pitchfork. When one of these big cats is brought to bay, usually with the aid of trained mongrel dogs, the hunter or hunters approach within a few yards of the quarry, which usually trees. They then await the charge. As a rule this wait is of short duration, for once the onça realizes that his retreat is cut off, he hurls himself at the nearest adversary with all the fury and determination of his kind, only to become a dying, snarling mass spitted on a spear. Luck is not always with the hunters, however, and many bad maulings and serious casualties have resulted from encounters with these powerful brutes, far sturdier



This is the largest nesting colony of white egrets in South America. This rookery is protected by the owner of the land and a watchman is always present during the breeding season to prevent poaching.



American egret (*Casmerodius albus egretta*). This is the larger of the two species of white egret found in the New World. It extends from our own southern states southward through Mexico and Central America, to the Straits of Magellan. In the days when trade in egret plumes was permitted, in the United States, the beautiful straight feathers of this species were known as "long whites" as distinguished from the smaller, curved ones of the Snowy Egret.



A typical outpost of one of several fazendas which compose the 76,000 acres of land controlled by the Pennas.

and heavier than the largest Indian or African leopards.

We were soon in the saddle, having first loaded the cameras and heavy baggage on a cart pulled by a yoke of oxen, and sent over a more circuitous route to avoid the lower ground. It was slow and hard going, for much of the campos was still under water, and in many places we had to swim our horses. For the greater part of the distance our ponies had to pick their way over wide boggy stretches, often floundering up to their bellies. They never failed to extricate themselves, however, even in the tightest places, and with a knowingness I feel sure only a Marajo cow-pony could show. On the other hand, they undoubtedly would be correspondingly helpless if called upon to do the work of our western ponies in the rocky Bad Lands.

As we rode across the campos, I had visions of making a cinema record with a mild approach at least, to the thrills of lion spearing by the Nandi or the Masai in British East Africa. No such luck awaited me, however, for as we rode up to the main ranch house such thoughts went the way of most day-dreams — a fresh jaguar skin was pegged out in the sun. Our messenger had arrived too late. The onça, a large female, had been shot out of a tree without much excitement. Her cub, a cute little unweaned kitten, had been captured alive. The youngster was presented to me, together with the skull and pelt of the mother. I left it with one of the cowboys



A jaguar trap made of bamboo to capture adult males. It is about fifteen by twenty feet with a small opening just large enough to admit a full grown animal. The males are lured to this trap by the presence of a female jaguar confined in a cage.



The jaguar—*Felis onca*—from a specimen once exhibited in the Zoological Park. The jaguar is the largest of the American cats, and this specimen was nearly the size of the Asiatic tiger. He was a powerful animal and in every way justified the reputed disposition attributed to these great cats. Jaguars are very active swimmers and take to the water readily. They are among the most adept of tree climbers and when the lands of their habitat are inundated, they are perforce compelled to live among the branches of the trees for indefinite periods. Both the jaguar and the tiger seem to relish a bath which is as abhorrent to the lion as to the domestic cat.



The hut of a cowboy in the interior. A strange combination of the primeval—with a touch of tropic climes—and the modern dwelling plucked from a ready-to-erect catalog.

who volunteered to become its foster mother by the bottle route. When I passed through here a few weeks later, I found that my pet had not long survived, which was another disappointment, as many of the jaguars that reach our zoos are reared in Marajo in this manner. Many are taken fairly young, and confined in large cages in which they mature and never leave until they reach the hands of some animal dealer in Para. Quite a number are shipped to Europe in the very cages in which they are trapped as adults.

On another fazenda on the island I was shown the method used to capture adult males. On a thickly wooded teso a tall strong bamboo stockade had been constructed. It was about fifteen by twenty feet in size, and with the exception of a removable section in the rear, the only entrance was a small opening just large enough to admit a full grown jaguar in a crouching position. Within this stockade, a female jaguar was confined, regularly fed by a man detailed as her keeper. Naturally enough, under such conditions she was as savage and morose a feline as I ever expect to see. She was confined in a large wooden cage, and alongside of this was another empty one of about the same size. This female charmer, through no design of her own, was nightly an unwilling siren, luring unsuspecting suitors to possible execution, or at best, imprisonment for life. Once an ambitious swain crossed the threshhold of that small inviting door, the lovelight was to vanish from his eyes, and his wheezy purr of courtship to turn to snarls of fury and then despair. No warning would come to him; only the dull thud of a heavy door that had dropped behind him. With the coming of day, comes his arch enemy, man, to either snuff out his life or drag him away from freedom forever. In the very cage that has trapped him, before another moon has come he may be on his way to menagerie or zoological park. And so among jaguars, as among men, some are fortunate, while many fail hopelessly, tragically in their struggle with "the way of all flesh."

On the fazenda Camburupy, there was quite a herd of wild Indian buffalo, (*Bubalis bubalis*) the caraboa of the Philippines, using the swampy bottoms of the Rio Cajuuna, which flows through the campos at this point. These buffalo were introduced into Marajo more than a century ago, and in certain parts of the island



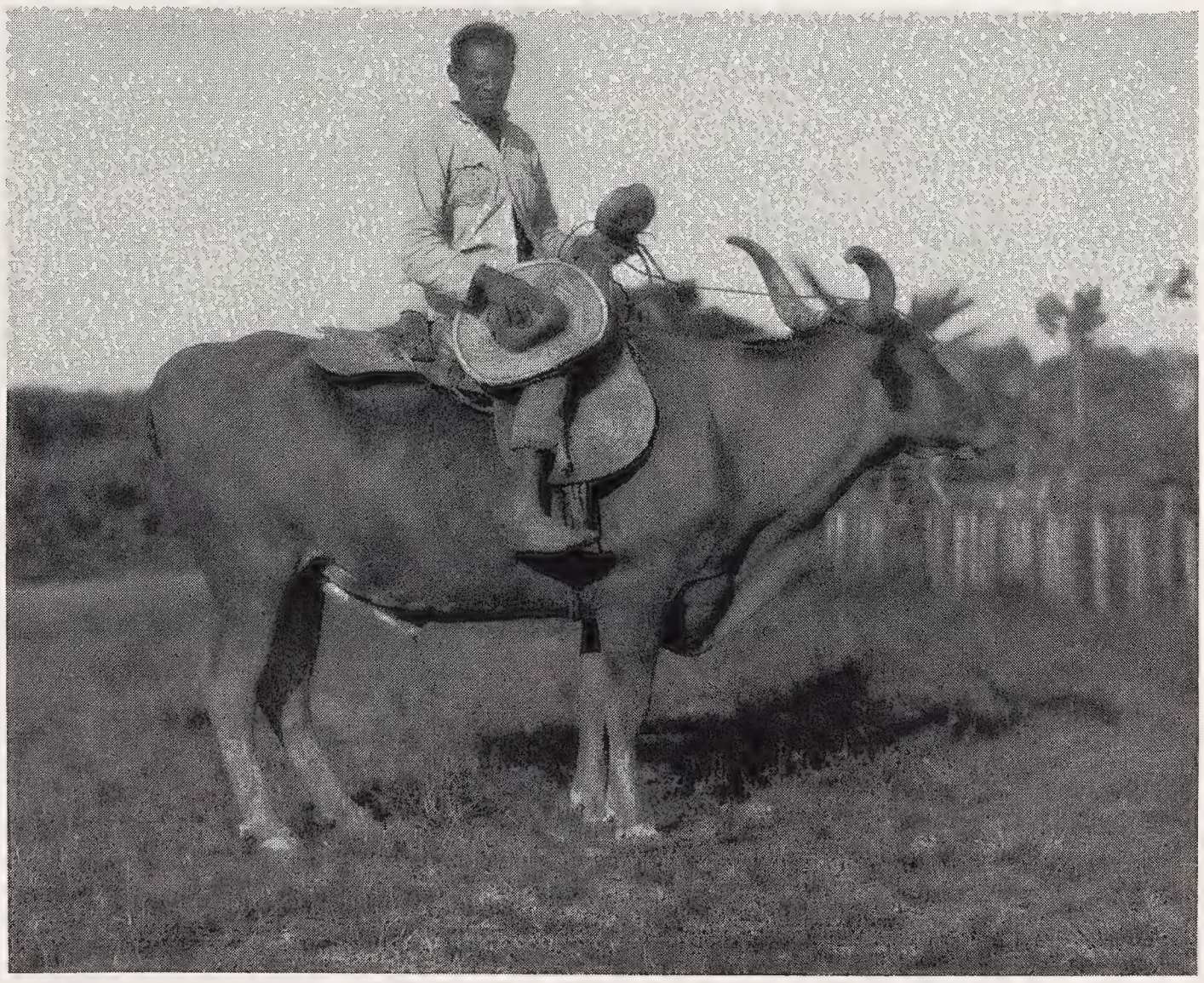
A herd of wild Indian buffalo on the fazenda Camburupy. They were introduced into Marajo more than a century ago. In certain places on the Island they are wild and aggressive.

they are dangerous and belligerent, particularly toward the whites, as is the case with these animals in their native habitat in the Far East. As a matter of scientific interest, I brought back to the United States a fine skull and horns of this introduced feral stock.

The island of Marajo literally swarms with *jacaré,* (the crocodiles of Amazonia) and every year when the waters recede they are slaughtered in thousands by the natives. It is mostly in the lakes and the igarapés that the larger ones are to be found. I was told that there were some very large ones in the Cajuuna, and I was anxious to try my luck at night - hunting these ugly saurians by flashing their eyes with an electric torch.

Among the cowboys at Camburupy was a husky negro, who I was informed was a "mighty jacaré hunter before the Lord." I was also told that he could imitate the love call of these saurians in a manner that would increase the blood pressure of the most confirmed jacaré bachelor on the island. I asked him to give me a sample of his art, and at once this dusky nimrod let loose an awe-inspiring bellow that seemed to start at his feet and struggle upwards painfully to at last find freedom from out an ivory studded cavity of huge dimension. It might be likened to the grunt of a huge porker, elongated and amplified to the volume of a lion's roar. I was convinced. I failed to see how any upstanding crocodile could ignore such a challenge. I organized a jacaré hunt then and there.

I had in my outfit a very powerful electric torch, capable of considerable throw. Armed with this and an eight millimeter Mauser, I started out about midnight to disturb the tranquility of the Rio Cajuuna. About this hour it was low tide, and the uncovered mud banks offered better opportunity for this kind of hunting. Except for the weird call of the goat-suckers, the stillness of the igarapé was almost unbroken save for the soft swish of the paddle



Among the cowboys at Camburupy, one, Jose, was a mighty jacare hunter. He could imitate with close accuracy the bellow of these great crocodiles.



The piranhas or man-eating fish of Amazonia. This fish, while only from six to nine inches in length, can bite off a finger in a flash. They go in large schools, and a man unfortunate enough to be attacked is sure to be seriously mutilated, and if he cannot quickly escape will be reduced to a skeleton in short order.

strokes, or the sudden splash of an iguana, capivari or other nocturnal creature dropping or diving into the stream as we approached. I sat in the bow, and the negro José with the jacaré voice sat behind me with the torch. In the stern was another boy to paddle. We had worked slowly down the igarapé for a few minutes, when José let loose his God-given gift of crocodilian oratory, but with far less force than during the tryout audition. Then all was quiet. It had sounded quite realistic to me, but then I was not a jacaré, and I wondered whether José had slipped in a false quarter-note somewhere. I am always mildly suspicious of self confessed experts. In a few minutes he gave the call again. This time, a little to my surprise, there came a deep throated reply like an echo out of the darkness, perhaps a hundred yards ahead. José muttered to the "boy" astern and he brought the canoe quietly to rest against the soft bank. Another rumbling grunt, then another came past my ear, and this time the answer was much closer.

"Jacaré grande." whispered José.

"Usa a luz," (put on the light) I whispered back, and the long widening beam of light pierced the darkness ahead.

Just beyond the range of its greatest power, under the shadows of some low hanging branches, two burning red balls loomed up like smoldering embers. The space between them told me that no small "croc" stretched behind these tell tale luminous eyes. José knew his flashlights, directing the beam of light carefully over my shoulder. The jacaré had left the water, and crawled up the bank about three feet from the edge. Carefully lining up the sights, I aimed a trifle below the center of the two fiery bulleyes and pulled. Instantly there was a thrashing of mud and branches and then utter stillness.

"Jacaré morte," snorted José.

Keeping the light ahead, we paddled to where those eyes had vanished. José was right; the jacaré was certainly dead. I had used a soft



Brazilian hawk-headed parrot (*Deroptyus accipitrinus fuscifrons*). Among the many species of parrot found in South America, this bird is distinguished by the decorative, erectile ruff of feathers borne on the neck. It is a favorite with the Indians, who frequently rear young birds from the nest, to keep as pets.

nosed bullet, and it had done its work far too well. I found the entire scalp had been ripped off the brute, and the head and shoulders reduced to a mass of bloody pulp, buried in the sticky ooze of the bank.

We pulled the carcass down to the water's edge and it was a fair sized crocodile, as near as I could judge about twelve feet in length. I regretted that I had not used a steel jacketed bullet, for the creature was far too mutilated to make it worth while to take the hide.

Hardly was the bloody carcass at the edge of the stream, and the taint of blood floating on the water, than the body of the jacaré was fairly stormed by hundreds of *piranhas* (*Pygocentries piraya*) churning up the surface of the



Blue-and-yellow macaw (*Ara ararauna*). There are nineteen species and subspecies of macaws, all found in tropical or subtropical America. They range in size from the great Hyacinthine, largest of living parrots, to the tiny Hahn Macaw, smaller than many parrakeets. Many are characterized by brilliant, even gaudy coloration. The present species is one of the finest, being blue above and bright yellow on the lower surface. It is found from Panama to Bolivia and Paraguay.

water, as they ripped at the exposed flesh like a pack of starved wolves. I shuddered to think what these little blood-mad demons of fish might do to a human being, unfortunate enough to fall overboard among them at such a time. I was also careful not to dangle my fingers over the side of the canoe again that night.

After many pleasant days in this part of the island, I started for the north coast and Cape Magoary. Returning by much the same route, I crossed the Rio Cambu onto the fazendas Magoary, one of the largest and most important of all the fazendas in Marajo. These great tracts, stretching from the Rio Cambu to



From an outpost north of the Cambu, we traveled in a large batalao drawn by five oxen. Along an igarape which flowed through the campos, the oxen swam the entire distance.

the cape, are owned by a wealthy Brazilian, Dr. Penna. When I made the purpose of my mission known to him, I was invited to be his guest, and horses, canoes, and men were put at my disposal during my long stay on these lands. Never have I experienced such wholehearted and graceful hospitality as was extended to me by the men in control of this wilderness country.

I made the trip to the coast by easy relays, staying at the various ranch houses and outposts distributed over this enormous fazenda, embracing more than seventy-five thousand acres. With much regret, I had parted with my companions on my return to the Rio Cambu, and with only the guides provided me by Dr. Penna I continued my explorations on the island. For the most of the way to Cape Magoary, I travelled in a large *batalao* (bateau) drawn by five oxen. Leaving a small outpost not far north of the Cambu, we traveled for the first three miles along an igarapé which flowed through an open stretch of campos, the oxen swimming the entire distance. Then we turned north into the vast *aruma-rana* marsh, following certain tracks known only to my chief guide. If you can imagine being towed through the great corn fields of Iowa, with the ground beneath you under about two feet of water, and with about what seemed a million mosquitoes to the square foot, then you may get some idea of this means of travel in these great aruma-rana marshes of Marajo. In many places, and for considerable distances, the oxen dragged the heavy batalao across practically waterless sections of the campos. At other times we were compelled to stop when one or more of the oxen became enmired. Several times it looked as though these patient beasts were hopelessly stuck in the deep ooze. Somehow, however, they always struggled free with the help of the other oxen and urged to greater effort by the shouts of the riders and wicked jabs in their rumps by the long pointed poles carried by the men as persuaders. To me it was wonderful how the men guided these awkward beasts through this wilderness; even more wonderful



In many places the campos was under water and for the greater part of the way our ponies had to pick their way over wide, boggy stretches. They never failed to extricate themselves, however, in the tightest places.

how our guide could find his way through the twisting, winding paths, the towering aruma-rana shutting out the view in all directions. Later on we came out of this high growth, and passed over long stretches of more open campos, but still following winding paths, made by small igarapés which wormed their way across the prairie.

Although we were traveling almost under the equator, and my only head covering a light felt hat, I did not experience the slightest discomfort from the sun. There was a constant breeze in the afternoons, and with so many things to hold a field naturalist's attention and interest, I was hardly conscious that I was fast acquiring a heavy coat of tan. Strange as it may seem, Brazil is the only place on the Equator where heat prostration, or so-called sun-stroke is a thing unknown.

Large flights of duck, *marrecas*, were constantly rising as we approached, sometimes in such numbers as to almost blot out the sun. They would make but short flights, however, and then settle in long regular rows with almost the same precision as the famous West Point line. Here and there large jabiru storks dotted the landscape, and as we slowly made our way through the narrow channels, hundreds and hundreds of wild cattle would gallop off across the campos, then wheeling about in groups, stand and gaze stupidly as we passed. Often we would see considerable numbers of *capivari*, those giants of the rodent family, feeding over the open country in the early morning and late afternoon. Always there was a wealth of bird life in great variety, while overhead long flights of scarlet ibis and egrets were nearly always in view.

For quite a while I made my headquarters at Jilva, the main fazenda of these Penna estates, and from here made many excursions in canoe and on horse back, collecting natural history material. My first trip to the seaboard of the island was to one of the Penna outposts at the mouth of the Rio Pacoval. It was about two hours canoe trip from Jilva by way of this



The baggage was sent across Lake Guara in dugouts. Instead of by yoke, the oxen were attached to the canoes by means of a rope fastened to their tails.

large igarapé, and in many respects even exceeded the Rio Cambu in beauty and wealth of aquatic bird life. As we made our way along its course, we were literally surrounded with jacaré large and small. Never in a single stream have I seen so many of these ugly saurians. I put well placed bullets in two very large ones, but both sank in deep water beyond recovery at the time. The following day I found one of these, about thirteen feet in length, washed ashore near the mouth of the igarapé. It was worthless as far as taking the skin, however, for the black vultures had made their usual feast and devoured the entire tail.

When we reached the seacoast outpost, Santa Ignez, at the mouth of the Pacoval, instead of being greeted with the bracing air of the broad Atlantic, an almost overpowering stench of fish hammered my olfactory nerves. It was not difficult, however. to locate the reason for these offending and far reaching aromas. They rose heavenward from thousands and thousands of fish, drying on long narrow platforms under the burning rays of the sun. From here and similar stations along the coast, countless tons of these dried fish are shipped annually for native consumption. Dried fish and *mandioc* (*farinha*) are the staple foodstuffs of the natives throughout the entire Amazon Valley, where the rivers and streams fairly swarm with a supply of fresh edible fish.

The unromantic odors of this important industry were somewhat leavened by the marine picture that stretched before my eye, as more than a hundred of the fishing fleet from far distant Vigia on the southern mainland, were operating off shore. Walking up wind along the beach, I was soon away from the smell of drying *Gurijuba, Purimutaba* and *Bagre,* and experienced the truly novel sensation of a fresh-water bath in the Atlantic Ocean. I was also much surprised at the utter absence of marine shells always to be encountered in more or less degree along a similar strand. Then I realized that here, the mighty sweep of the Amazon's waters was denying such mollusks their necessary saline environment.



On arrival at Lake Guara, we were obliged to swim our horses for nearly a mile. The lake received its name from the great nesting colony of scarlet ibis, locally known as guara.

On my excursions out from Jilva, I saw many types of the island's wealth of animal life, including giant anteaters, small arboreal prehensile tailed ant-eaters and porcupines, howler monkeys and marmosets, ocelots, coati-mundis, the South American cousins of our raccoons, and many other interesting mammals, and a wealth of reptile life, but I was not fortunate enough to run across an adult anaconda, though Marajo is famed for the number of these giant snakes taken there. Somehow, I feel that the granddaddy of this reptile is hiding somewhere on this island, and on my next trip I expect to make a strong effort to bring him back to the Bronx.

After considerable stay in and about Jilva, I was unsuccessful in my search for archaeological material, and so headed farther inland to a point called Macacao, where I was to spend many most uncomfortable but happy days, for it was here I took from the ground one of the four important collections now existing in museums, of the wonderful pottery left by the prehistoric races mentioned earlier in this account.

On my way to Macacao, we crossed a fair sized lake known as Lago Guara, which received its name from the fact that here is located the greatest nesting colony of scarlet ibis, (locally known as *guara,*) known to exist in the North of Brazil. In the evening I have seen strings of these beautiful birds more than two miles long, returning to their nests from their feeding grounds on the coast. Any attempt to estimate the number of these birds using this locality seemed to me hopeless. The small trees and growth that lined the shores of the lake seemed to be constantly in full bloom with brilliant scarlet splashes, and the effect of it all under the blue of the tropical sky made a picture never to be forgotten.

In the midst of a great aruma-rana swamp, some three miles from the lake was the teso of about two acres in extent, known as Macacao. In order to reach this lonely spot, I was compelled to secure riding oxen from a fazenda a



Along the shores of Lake Guara, the trees and bushes fairly bloom with countless numbers of scarlet ibis. This is the largest rookery in North Brazil.

few miles distant, since these are the only animals that can make their way through many of these marshy places. They do not lose their heads when enmired, and their splayed hoofs spread, and then contract when withdrawn from the gripping ooze. On this little "island" in the swamp lived a negro, named Seabra, his wife and three small children, the eldest about ten. Only Seabra and this boy, knew the way into Macacao. With the tow-lines of two canoes attached to the tails of two of the patient bovines* I had secured, we made our way to this teso, and I was given the guest chamber in a tiny three roomed, mud-walled, and dirt floored hut. This I shared with a native assistant. Here for many days I lived on a meagre diet of fish and farinha, leavened occasionally with a duck or scarlet ibis, or marreca eggs brought in from the marsh by the boy. The last clutch of these eggs I passed up when I discovered they contained well developed embryo ducks, but Seabra and his tribe ate them with great relish.

Strange to say, there were no mosquitoes here between sunrise and sunset, but at 6:10 P. M. they invariably arrived on schedule and in such numbers that one's hammock and *mosqueteiro* (mosquito-bar) was the only recourse. I shall never forget the nights at Macacao. Several pigs were given sanctuary in a hut at night, for if they were left without, they would be devoured by the jacaré that nightly paraded across the teso. Three mangy mongrels were also nocturnal tenants. No taxis were available, so the oxen, our only means of escape, were well secured in a corral. And so each night with the setting sun I sought early repose, while the children cried with colic, the pigs fought for desirable space on the floor, the dogs whined or barked, the oxen bellowed

* I had previously found that this is a common practice and means of transportation in Marajo. It usually works quite well, but it would certainly never get the approval of our S. P. C. A., for not infrequently an ox loses his caudal adornment unless the line breaks under an overstrain.



The beautiful and brilliant Scarlet Ibis (*Eudocimus rubra*) is no longer found in the United States except possibly for solitary individuals. In color it is one of the most beautiful of the scarlet plumaged birds. On Marajo Island it breeds in hundreds and it is found also along the mouth of the Orinoco and on the coast of Northern South America. In captivity the color fades gradually, which probably is due to the lack of certain foods obtainable only in the habitat of the birds.

in the corral, and above it all the continual zoom of the *caripana* (mosquitoes) swarming about my hammock with hypodermic intent. Yet with all these discomforts, I was happy indeed, for each day brought new treasures of the past from the black soil of the teso. Yes, these were the last and happiest of my days at Marajo, for here I met with success far beyond my dreams. And now I wish again to return to this wonder island of the Amazon, where in a short while Noah could have loaded his Ark below her summer marks.

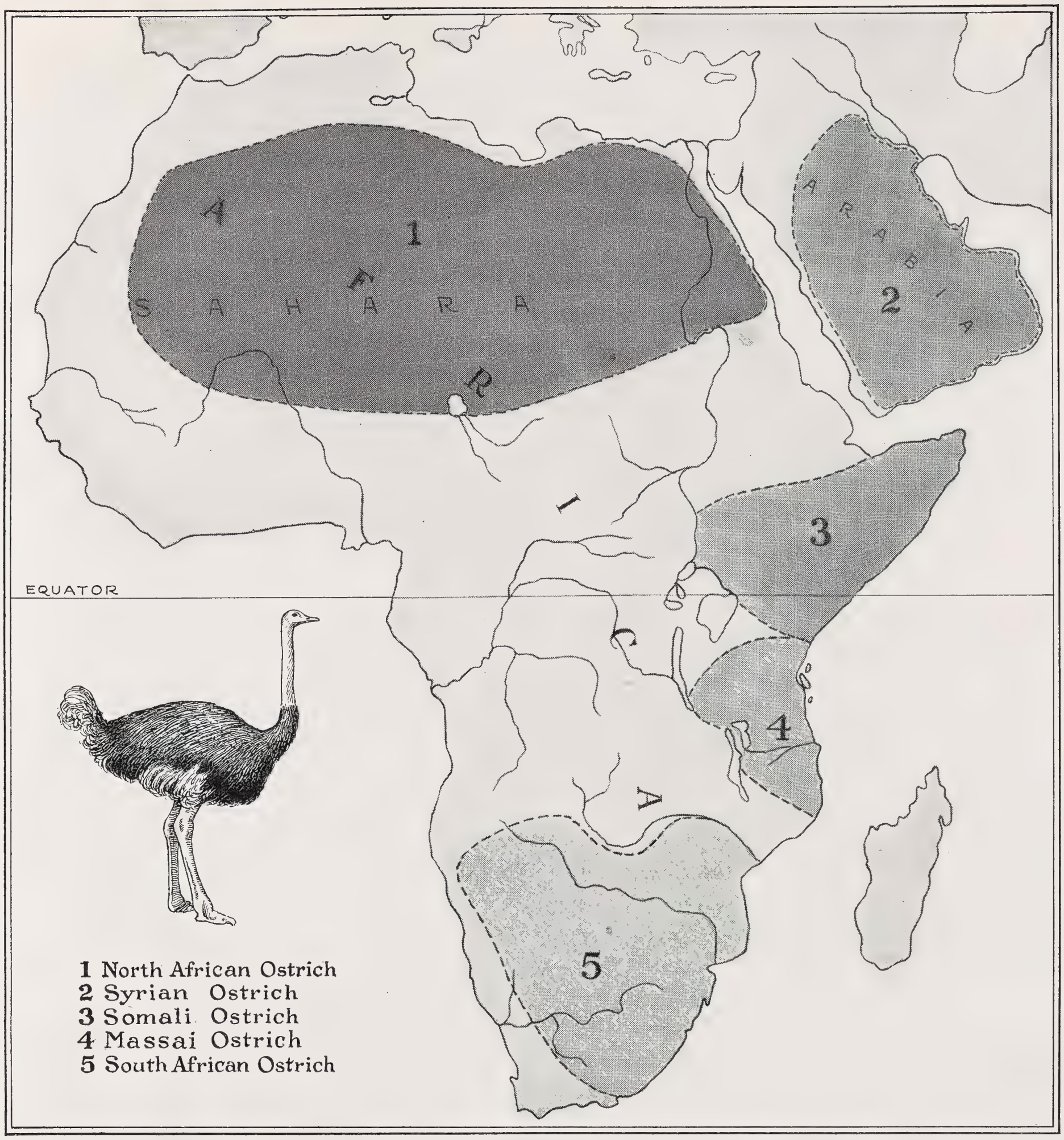








Upper—Cleaning pottery taken from the ground at Macacao, Marajo. *Center left*—Bird-shaped redware jar with human face in relief and red painted decoration. *Center right*—Large bowl with fluted rim, black and red painted decoration. *Lower*—Oxen attached to a batalao hauling the pottery through the aruma-rana swamps, Macacao.



Sketch-map showing the habitat of the Ostriches. It is intended solely to give a general idea of the distribution of these birds.

The Struthious Birds

Part II. The Ostriches and Rheas

Lee S. Crandall

Illustrations are from photographs made in the Zoological Park unless otherwise noted.

The Ostriches, of course, are the largest of living birds, a fully adult male often reaching a height of eight feet or more and a weight of three hundred pounds. Five forms are generally recognized, extending from the deserts of Syria and Arabia, over the open country of northern and easten Africa, almost to the Cape. The differences are slight, chiefly those of size, and variation in the color of the neck and legs. The adult males of all are black, with white wings and tail, while the females are uniform gray.

In the soft, loose plumage of the Ostrich, the tiny hooklets or barbicels, which cause cohesion

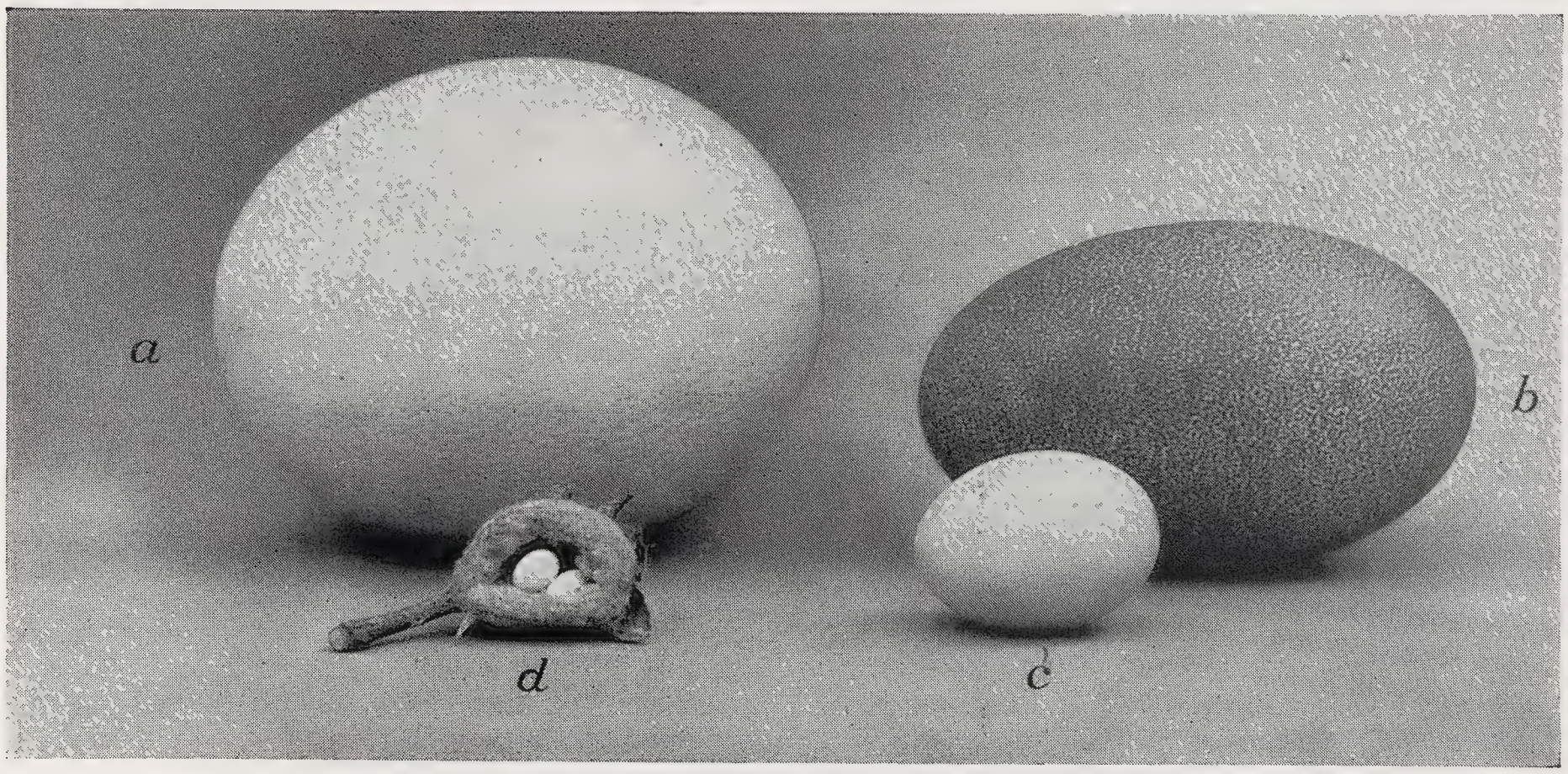


Flock of North African Ostriches (*Struthio camelus*) on their range in the Zoological Park. The male, a splendid bird, came from one of the California farms in 1918, the year that marked the final breaking up of commercial plume-growing in America. The females were secured in 1919, from the ill-fated ostrich farm at Bloomsburg, Pennsylvania.



Development and growth of an ostrich feather.

in normal feathers, are degenerate or altogether lacking. However, there has been a gain in the direction of beauty, for few things in the world are more lovely than an ostrich plume. The finest feathers are those borne in the wings and tail of cocks, and they have been sought as ornaments from the very earliest times. In the latter part of the past century, this demand resulted in the development of farms devoted to domesticated ostriches, chiefly in South Africa. The new industry grew with great rapidity and at its peak earned an income of many thousands of pounds annually. However, the resulting abundance of ostrich plumes eventually defeated its own purpose, for fashion finds no delight in things that are common. The graceful, drooping feathers soon became unsaleable and the great birds that bore them were slaughtered by the thousand. Their owners pocketed their loss and turned their paddocks into sheep runs. Already the natural reaction is taking place; small ostrich feathers are appearing on hats in the exclusive shops of Paris and New York. No doubt the curious race between fashion and industry will be run again, with the victor never in question.



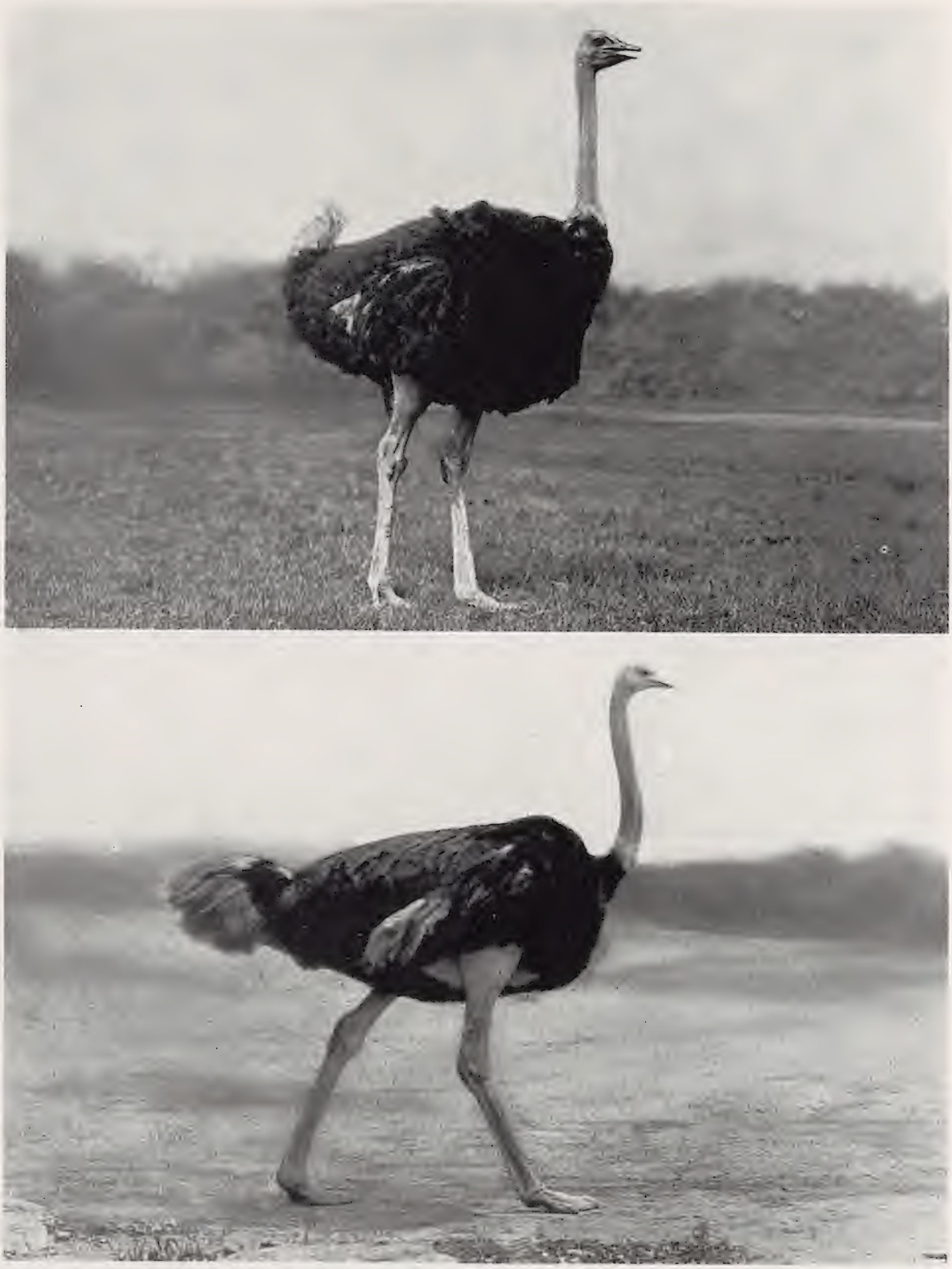
Comparative size of eggs of *a*, ostrich; *b*, cassowary; *c*, domestic fowl; *d*, hummingbird. The egg of the ostrich weighs from three to four pounds and its capacity is equal to about twenty fowl eggs.



a, Head of ostrich; *e*, Head of Rhea. The small brain capacity and well developed eyes are striking characters. *b*, position of ostrich's foot in running, the weight being carried chiefly by the middle toe. *c*, standing position, in which a portion of the weight is supported by the outer toe. *d*, feet of rhea. While three toes are still present, the middle one is of greatest importance.



Upper—South African Ostriches (*Struthio australis*). The male—*left*—is distinguished from his mate by the black body plumage, with white wing and tail plumes. The adult female is a uniform dark gray. *Lower*—South African ostriches enjoying a shower bath. Because of the soft, loose character of the plumage, it offers no resistance to water and the birds quickly become thoroughly soaked.



Upper—Male ostrich on the alert. In the wild state, no creature is more difficult to approach or stalk. *Lower*—Although a dangerous antagonist when cornered, the ostrich prefers to escape his enemies by running. Even when walking, as shown above, the stride is long and graceful.



Upper—A sharp turn at full speed, with one wing partly extended as a counterbalance. In spite of its great weight, the ostrich is surprisingly agile as well as swift. *Lower*—In full stride—a picture of grace and muscular force. An ostrich is said to be capable of a speed of sixty miles an hour. At any rate, he can easily outdistance the swiftest horse.



Upper left—North African ostrich in the snow. In spite of the apparent inadequacy of the plumage as a protection against cold, we have found that our ostriches thrive best when kept out of doors the year 'round. *Upper right*—The roar of the male ostrich is a series of loud booming sounds, not unlike the roar of a lion. The neck is widely distended with air during the process. *Lower left*—South African Ostrich. The slenderness of this species as distinguished from the North African bird, is well illustrated. *Lower right*—South African ostrich. In this species, the bare portions of the neck and the legs are blue, while in the North African bird, these parts are red.



Upper right—The courtship display and dance of the male ostrich is a sight of unusual beauty. This is the first phase, in which the wings are alternately raised and lowered. *Upper left*—Both wings are then extended, while the bird moves in small circles. *Lower*—In the final stage, the bird drops to the ground, moving body and wings from side to side, the head and neck following in graceful, serpentine movement. The lovely wing plumes are now seen to the best advantage.



Ostriches at the Ostrich Farm in Jacksonville, Florida. This was one of the attractions at a small resort on the outskirts of the city. It was developed also in a commercial way. The pictures were made about twenty years ago, and at that time the flock was in a very prosperous state. The feathers were sold as single plumes, made into scarfs and the smaller ones were used for fans. The feathers were taken from the birds at their most perfect state of development by cutting. This left the end of the quill imbedded in the skin and the bird suffered in no way by the operation. When the quill dried it was easily drawn out and the new feather then commenced to grow.



The breeding birds were given the freedom of large yards where the warm sand provided admirable means for the rude nests which the birds hollowed out. Both male and females assumed the responsibility of incubation. The two pictures at the top show the male and female on the nest. They were quite fearless and proceeded with their duty heedless of any crowd that might gather at the fences.



The Jacksonville climate was admirable for the breeding of these great birds, and one of the interesting features was this old colored man and his fledgling birds which he seemed particularly gifted in rearing. He was very patient and kindly brought out this young brood for photographing.



Some of the large male birds were used for riding and driving. The riding being done without saddle, the rider simply slipping his legs under the wings, the bird then ran around an enclosed track with great speed. The weight of the rider seemingly offering no inconvenience. Catching the birds for this purpose was anything but sport; none of them required pursuing. If the boy's chance was good he grasped the bird's neck and pulled it down. The ostrich was then practically helpless. If he missed getting a hold his only salvation was to fall flat to the ground. In the case of a catch, the bird was immediately hooded, when he could be led around with ease.



A white rhea, with billowy plumes raised, is a sight of rare beauty. This is an unusually fine specimen. When the bird ruffles its feathers they form a perfect cascade of billowy plumage, so light and graceful as to seem like a halo rather than a material structure.



Sketch-map showing the habitat of the Rheas. It is intended to give a general idea of the distribution of these birds. The range of the Common Rhea probably extends into Patagonia.

Part II. The Struthious Birds—Rheas

The Rheas are the only representatives of the struthious birds found in the Western Hemisphere. Hardly more than half the size of the Ostrich, they bear a superficial resemblance to the larger bird. The feathers are similarly soft and loose, though they lack the ornamental value of the African plume. Unfortunately, they are curiously well adapted for use as feather dusters, and so many thousands of the birds have been slaughtered for this utilitarian purpose, that their numbers have become dangerously reduced.

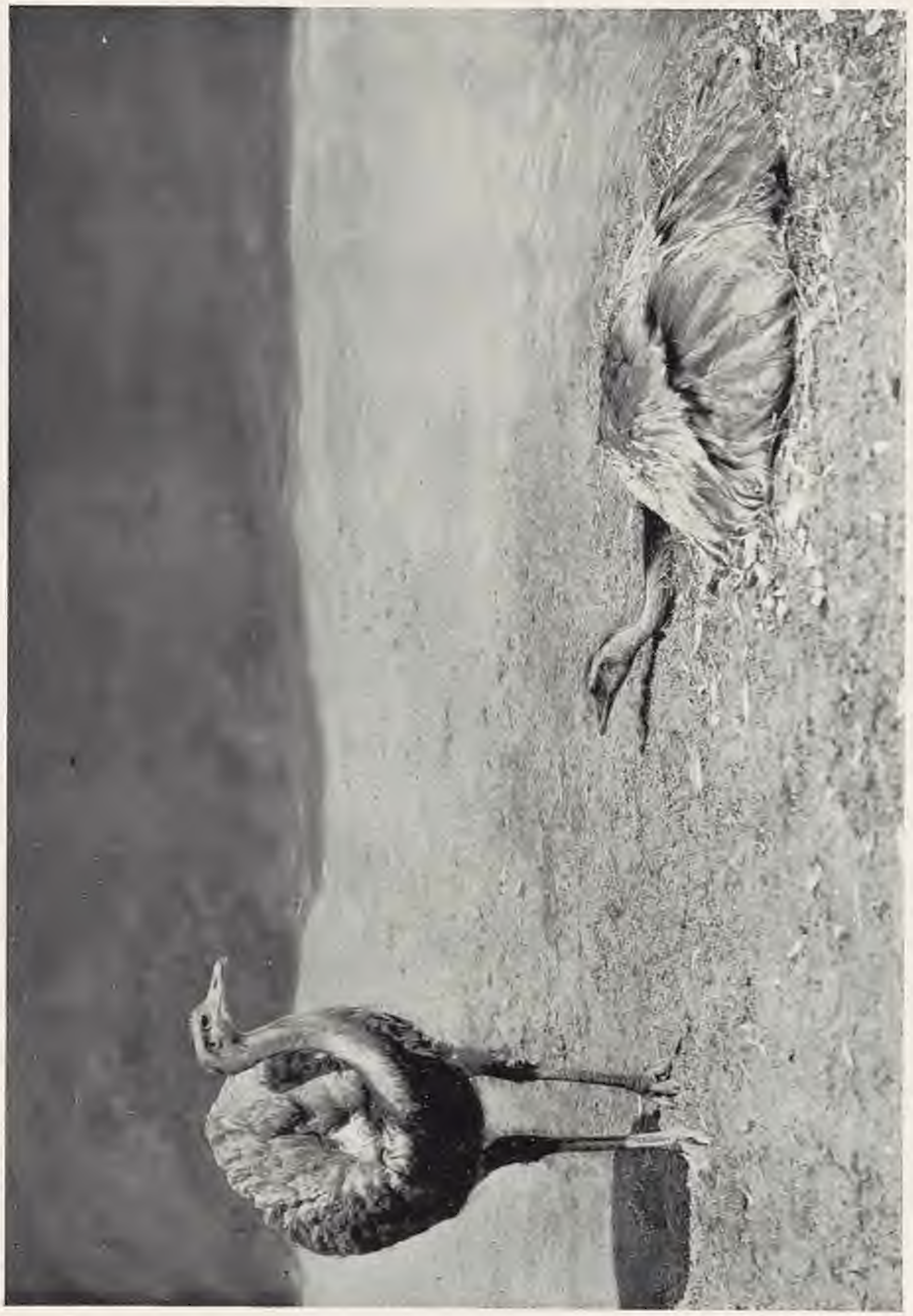
There are three species of Rhea, ranging over the plains of northeastern Brazil, Argentina, and Patagonia, as well as the higher plateaus of Chile, Peru and Bolivia.



Common rheas (*Rhea rothschildi*) in the Zoological Park. The plumage of the rhea, while soft and loose, lacks the beauty of that of the ostrich. However, it has been in great demand for making dusters, and until within recent years, great quantities were imported for this purpose.



Common Rhea (*Rhea rothschildi*) in the Zoological Park. The rheas, in habit and appearance, have a general resemblance to the ostriches, although this likeness appears to be one of parallelism rather than of close relationship.



A pair of great-billed rheas (*Rhea americana*) in the Zoological Park. The male is incubating, while his mate looks on with indifference. The care of the eggs and young, like the emu, is solely the task of the male bird. There is a slight growth of feathers on the thighs, differing in this respect from the ostrich.





In the rheas, as in the emus, incubation of the eggs and care of the young are left to the male alone. Above, father common rhea with chick. *Below*—male great-billed rhea incubating in the Zoological Park.



White rheas, sometimes pure in color but often with a trace of gray on neck and thighs, are frequently seen. These albinistic sports have been cultivated in captivity, so that they are now well established.

NOV 27

Bulletin

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The design reproduced on the cover of this number of the Bulletin was made from a water color drawing by Paul Bransom. It was drawn expressly for this purpose and presented by the artist to the New York Zoological Society as a gift of appreciation.

BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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Long-tailed Bird of Paradise. *Epimachus fastosus meyeri* Finsch.
Immature Male.

BULLETIN
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The New York Zoological Society's Expedition to New Guinea

LEE S. CRANDALL

Curator of Birds, Zoological Park

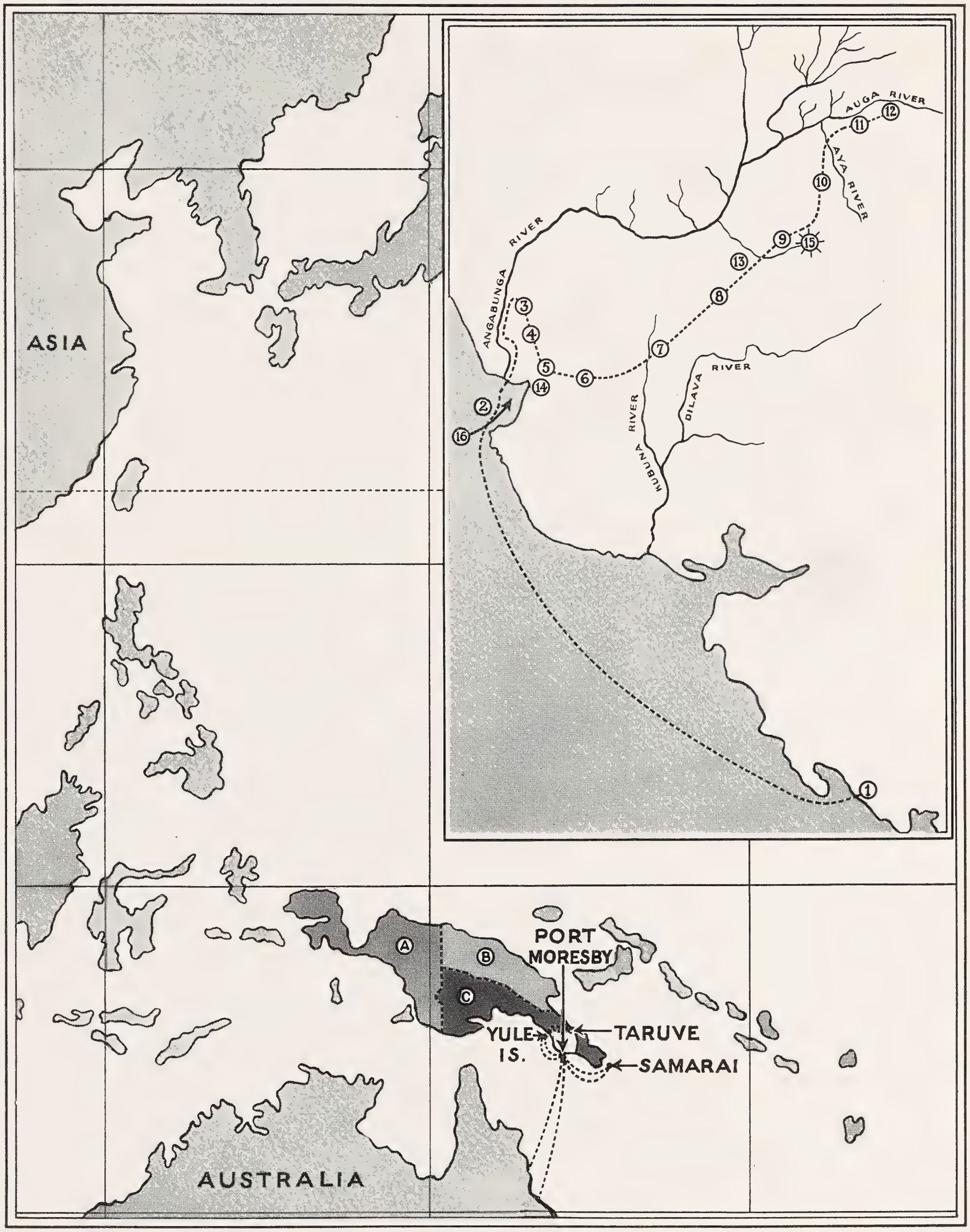
Illustrations by the Author from photographs made in New Guinea, and from the living birds in the Zoological Park by the Author and Edward R. Osterndorff.

TWO things were of primary importance in making plans for the Zoological Society's expedition to New Guinea. It was necessary to find a point of entry, from which the habitats of the greatest number of species of birds of paradise could be reached, in the shortest possible time. It was also essential to secure the services of someone with actual field experience in New Guinea. The solution of both problems was found when Mr. J. E. Ward, of Sydney, Australia, replied favorably to a cabled inquiry. Not only was he willing to undertake the project but he suggested the Central Division of the Territory of Papua, as the district most likely to yield success. While naturally we were pleased at Mr. Ward's acquiescence, we did not, at the time, fully realize our good fortune. Without his knowledge, enthusiasm and powers of endurance, the expedition probably would have had a very different outcome, for to an utter stranger, no land is more cruel and difficult than New Guinea.

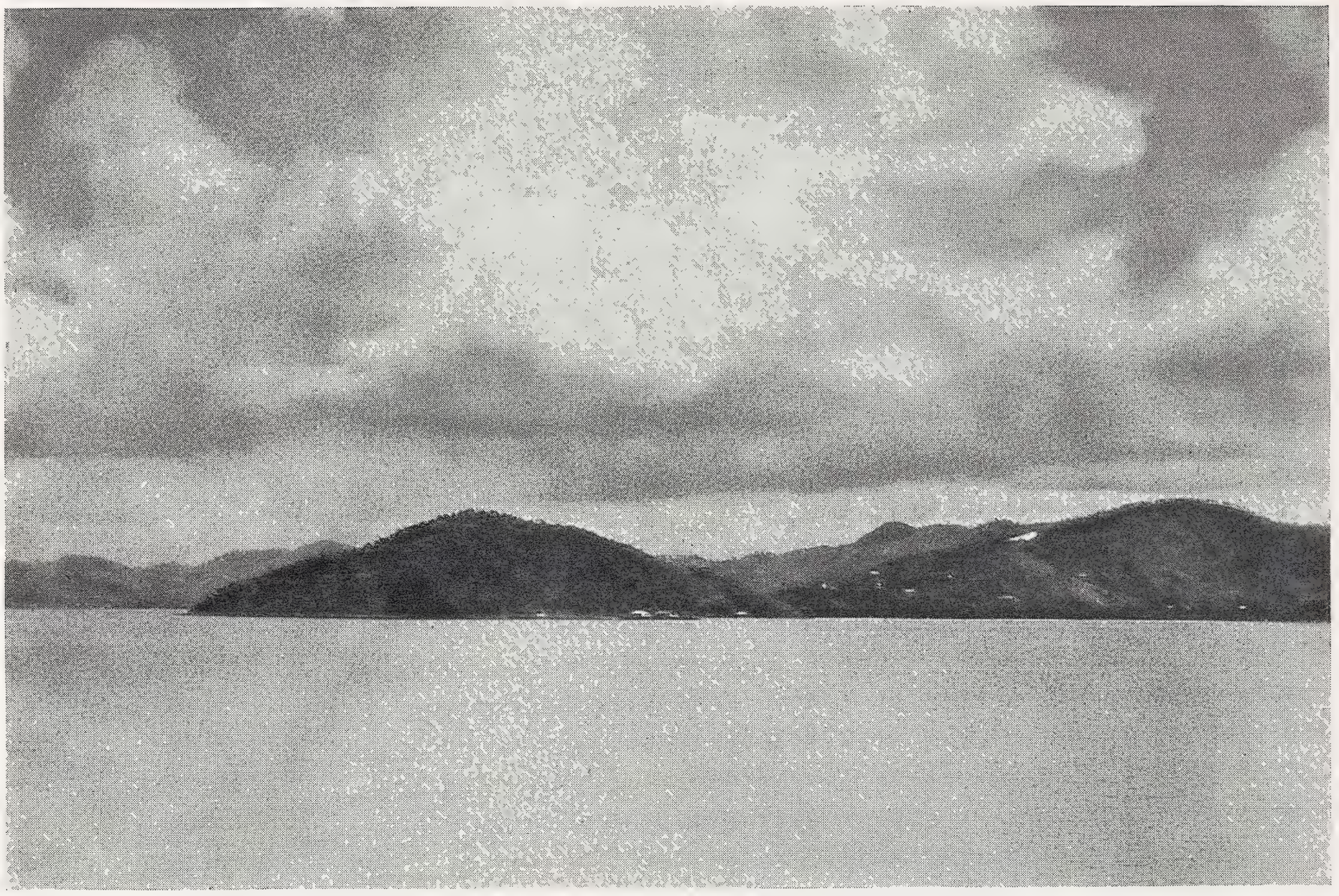
Sailing from San Francisco, August 9, 1928, I arrived in Sydney on September 4. No sooner had I been installed in the hotel where Mr. Ward had made reservation for me, than he informed me that His Excellency, Sir Hubert Murray, Lieutenant-Governor of the Territory of Papua, was a fellow-guest. This was an unexpected stroke of good fortune and I lost no time in taking advantage of it. The birds of paradise are rigidly protected in British territory and permits to collect them for any purpose are difficult to procure. A brief cable message from His Excellency had assured us that a license for a very limited number of birds would be issued on personal application. We had proceeded in the hope that some extension of the privilege might be granted.

Soon I was in the presence of the man whose explorations, firm ideals and unfailing sympathy with the natives, have so ably upheld British colonial policy for more than twenty-five years. He graciously received me at breakfast and allowed his grilled kidneys and bacon to cool while I pleaded my case. Before the interview ended, he gave me a pencilled note requesting the Government Secretary at Port Moresby to use his discretion in the issuance of a license. Typically British in reticence, to be sure, but I knew it was all I required and I was duly grateful. My happiness was not lessened when His Excellency informed me that he was off for six months' holiday in England. Had I arrived in Port Moresby without that hastily scribbled note, I should surely have met with difficulty.

The Burns-Philp steamer *Morinda* is the



Sketch map of New Guinea in its relative position to the adjacent islands. Section in upper right represents the area northeast of Yule Island covered by the expedition. A. Dutch New Guinea; B. Territory of New Guinea; C. Territory of Papua; *Upper right section.* 1. Port Moresby; 2. Yule Island; 3. Jesubaiboa; 4. Inawaia; 5. Inawaibui; 6. Aropokena; 7. Kubuna; 8. Diene; 9. Matsika; 10. Deva-deva; 11. Popole; 12. Taruve; 13. Kekefi; 14. Bioto; 15. Mt. Kebea; 16. Hall Sound.



Port Moresby from the eastern or seaward side. The town lies in the hollow between the two hills in the foreground. During the dry season, it is a hot and dusty place.

connecting link between Sydney and Port Moresby, making the 3,600 mile round trip once monthly. She was to have sailed about September 15th, but she had to wait for a cargo of rice to relieve a shortage in Papua, so that she did not arrive in Port Moresby until the early morning of October 4th.

We were on deck at dawn, to see the sun rise behind the eastern hill of the promontory on which Port Moresby lies. The end of the dry season was drawing near and the low, bare hills were scorched and brown. The town itself, nestling between them, looked dusty and desolate. Yet I thrilled at my first sight of the land that had haunted my mind for so many years—the land that attracts the naturalist as a magnet draws a needle.

Long before the official hours of business, I found my way to Government offices. When Mr. H. W. Champion, the Government Secretary, arrived, he received me at once and proved both kindly and sympathetic. Relieved from any official restriction by the note from Sir Hubert Murray, Mr. Champion granted my request for permission to collect a number of birds of paradise sufficient to make the trip worth while —if we could get them! An hour later, I was the proud holder of a collector's license, duly issued by Mr. Baldie, Resident Magistrate, as well as a receipt for £25, the established fee.

In the meantime, Mr. Ward had been doing wonders at Burns-Philp's store, purchasing supplies and trade goods, to supplement those brought from Sydney. When the *Morinda* sailed that night for Yule Island, which she visits every other month, we were safely aboard, everything in order.

A word on geography, at this point, will help clear the situation. The island of New Guinea is about 1,400 miles long and has a surface area of approximately 300,000 square miles; amongst the islands of the world, it is exceeded in size only by Greenland. Geographically, it is known also as Papua, a term which has resulted in great confusion. The western half of the island belongs to Netherlands and is known as Dutch New Guinea. The eastern half is divided into two portions, the southern division of which, once known as British New Guinea, passed into Australian control in 1906



Port Moresby from the harbor. At the right, are the buildings of the business section of the town. Beyond, are the offices and residences of various government and other officials.

and was promptly renamed as the Territory of Papua, commonly abbreviated to Papua. The northern section of the eastern half of the island, formerly known as German New Guinea, is now governed by Australia under mandate from the League of Nations and is officially known as the Territory of New Guinea. Consequently, the names New Guinea and Papua, apply not only to the entire island but, locally, to its divisions.

Yule Island lies about sixty-five miles west of Port Moresby, and is separated from the mainland, two miles away, by the waters of Hall Sound. Early on the next morning after leaving Port Moresby, the *Morinda* anchored off the dock of the Mission of the Sacred Heart, at the eastern end of the island. As soon as our rather bulky outfit had been placed in the Mission store-house, we were greeted by Mr. Speedie, a young Patrol Officer attached to the staff of Mr. Grist, Assistant Resident Magistrate of the Central Division. We spent the night as the guests of Mr. Speedie, who occupied a little thatched house at the Government headquarters, on the north shore of the island, adjoining the Mission grounds.

As there were no canoes available, we were in a quandary as to how to reach the mainland, but after long and involved bargaining, we were able, next day, to arrange for transport in a trader's launch. The Angabunga or St. Joseph River empties into Hall Sound opposite Yule Island, and is navigable for some distance by small craft. However, the entrance to the river is obstructed by a barrier of mud and sand, which can be crossed only at high tide by boats of very shallow draught. In order to make certain that we should cross the bar, it was necessary to avoid overloading the launch and my heavy motion picture films, which later proved a constant worry and encumbrance, had to be reduced to 2,000 feet. About two o'clock that afternoon, we managed to get into the river and made fair progress in spite of a swift current.

For several miles, the river is bordered by a heavy growth of mangroves and nipa palms. There were many birds here and we had our first view of a considerable number of species,

particularly white egrets, ibises, white cockatoos[1], a single great black cockatoo[2] and flocks of pink and green Geoffroy parrots[3].

After we had passed through this swampy coastal area, the current became swifter and our progress was so slow that eventually we were overtaken by darkness. We tied up at the bank and passed a most uncomfortable night in a heavy downpour of rain, the prey of hordes of greedy mosquitos. At dawn next morning, we were again under way and a few hours later, arrived at the landing place of Jesubaiboa, commonly called Ishibaibo, one of the Mekeo villages.

A great crowd of natives, by some mysterious means aware of our coming, had gathered, and had brought a large quantity of copra, of their own making, in the hope of selling it to the launch owner. In the heat of barter, they took little notice of us, so that I had a few moments in which to recover from the shock of my first contact with these wild looking, nearly naked savages. It seemed to me then that I could never feel comfortable amongst them. Later, I made many friends and found them, for the most part, a laughter-loving, loyal and kindly people.

Having disposed of a good part of their copra, the people were in holiday mood and not inclined to trouble about us, though a few who remembered Ward, came forward and shook hands, white man fashion. Finally, with the help of one of Ward's old bird boys, named Opu Kaki, now become village constable, we managed to persuade them to carry our duffle through their own village to Inawaia, about four miles from the landing. Here the usual uproar about payment ensued, resulting in dissatisfaction which later had its effect when we tried to get carriers for the trip to the mountains.

As in most of the Mekeo villages, there is a small but comfortable rest house in Inawaia, built of native materials, for the accommodation of occasional visiting patrol officers. Here we were soon installed, with our bulky cages stored in a rickety police boys' house, across the way.

Mekeo is a district of considerable extent,

[1] *Kakatoë galerita triton.*
[2] *Probosciger aterrimus goliath.*
[3] *Geoffroyus geoffroyi aruensis.*



Mountains of the Main Range, as seen from Yule Island. At the left, is Mount Yule, more than 10,000 feet high. The sharp peaks in the center are known as The Needles. The arrow at the right points to The Gap, which separates Mafulu from the Ambo country. These mountains are at least fifty miles distant from Yule Island, and after seven o'clock in the morning are usually obscured by mists.



Hall Sound, from Yule Island. The mainland, which is no more than two miles away, is barely visible and the distant mountains are entirely hidden by mist and cloud.

practically flat and not much higher than sea level. The soil is fertile and stoneless, and supports a number of large and powerful native villages. It is traversed by excellent native tracks, so that walking is not only easy but pleasant in the dry season. During the period of rains, which extends from December to March or April, or when occasional floods occur, much of the country is inundated and travel difficult or impossible. In most sections, the primeval bush has been cut down, by generations of native gardeners, and has been replaced by an almost impenetrable tangle of second growth, or by coarse saw grass, ten to twelve feet high.

There are many birds here, of course, but only one bird of paradise. This is the green manucode,[1] which is abundant from Yule Island, through Mekeo at least to Kubuna, at about 200 feet elevation, where I noted the last specimen, as we climbed into the mountains. The thin, piping note of this species is a striking feature of the early morning bird chorus in the lowlands.

[1] *Manucodia ater alter.*

Another most interesting bird of Mekeo is the fawn-breasted bower bird.[2] We examined a number of the bowers of this species, which are usually placed close to villages or near the native tracks. We measured one, which was built on a mound of twigs, four feet long, two feet wide and fourteen inches high. The true bower, built of slender twigs set in two parallel rows at the center of this heap, was fourteen inches long, eleven inches high and ten inches wide, over all. The "front" of the bower, and the tips of the twigs, were handsomely decorated with small pale green fruits of three distinct sorts. These bowers, of course, are used entirely as playhouses, and not for nesting purposes.

After a day or two in Inawaia, devoted to the sorting of luggage, much of which had to be stored until our return, we had no difficulty in getting the local people to carry our outfit the eight miles to Inawaibui, the next village. Here, however, we met with a distinct reverse, as only nine boys were willing to proceed and we

[2] *Alphachlamydera cerviniventris recondita.*

needed at least thirty. We overcame this obstacle only by dispatching runners to Yule Island, asking for help from the police. The Government ordinarily does not undertake to secure carriers for expeditions other than its own, but the next day a native sergeant appeared, accompanied by a private and a carrier, who, thanks to Mr. Speedie, brought three more tins of my precious film. By means best known to himself, the sergeant persuaded a sufficient number of boys to "volunteer," so that we were able to proceed. We promised him a present on our return and when we reached Yule Island, two months later, this efficient gentleman appeared and was pleased to express his satisfaction with four sticks of trade tobacco, which Ward gave him from our diminished stores.

Soon after leaving Inawaibui, we encountered low foothills and here we heard the first clear, ringing calls of Count Raggi's bird of paradise.[1] Thereafter, during our entire stay in the mountains, we were seldom out of the sound of these stirring notes, so characteristic of New Guinea. For five days we continued our march on a track frequently almost impassable, ever up and down precipitous razor-backed ridges. Fortunately, Mekeo's mosquito hordes had been left behind but we were constantly attacked by the land leeches that swarmed wherever there was a trace of moisture. After leaving Mekeo, there are no villages on the track until one has penetrated far into the mountains, but at intervals of from ten to fifteen miles, there are small rest houses for the benefit of patrol officers. By good fortune, we managed, at each stage, to reach shelter before the heavy rain which fell every afternoon, although the boys, who are invariably dilatory when going away from home, were not always so fortunate. We ate only two meals daily while on the march, since, to avoid the rain, it was necessary to push on as rapidly as possible.

Finally, we reached a point in the southwestern extension of the Owen Stanley range, known as Deva-deva. The elevation is about 4,000 feet, and the airline distance from Yule Island approximately forty-five miles. There had once been a village here, from which we

[1] *Paradisaea raggiana.*



Motumotu canoe at Yule Island. This unwieldy vessel has come from a point about fifty miles west, to bring native-made copra to the trading post. These are dangerous waters to navigate.



Motumotu canoe. It is really composed of two large heavy canoes, hewn from tremendous trunks, and decked over. It is propelled by means of sails and oars. A most seaworthy craft, and the islanders are expert mariners.

had expected to procure native food to replenish our scanty stores. Unfortunately, we found that this site had been abandoned. Its former inhabitants had scattered up and down the steep slopes of the valley of the Aya River, which flows northward into the Aduella, one of the upper tributaries of the Angabunga. With an immediate food shortage in sight, most of our boys promptly deserted. They were a mixed lot, gathered from several villages, suspicious of each other and constantly malingering. Really unwilling to undertake the journey in the first place, they had made us continual trouble and we were not sorry to see the last of them. At the same time, we were left in an awkward position, since we had neither carriers for the return trip, nor sufficient food to remain very long where we were.

Eleven boys remained faithful. On the day following the desertion, one, a very intelligent fellow, came forward and volunteered to return to Inawaia, with five others whom he would select, and bring to us one hundred and sixty pounds of rice we had left there. It seemed to us unlikely that the delegation ever would return or that we ever should see our rice. On the other hand, we could lose little and there was always the chance, however slim, that the thing might come off. After some consideration, we consented and the party set out, each boy carrying his blanket, a small packet of rice and two ship's biscuits—supplies for the trip!

As we now had only ourselves and five boys to feed, the strain on the commissary was somewhat relieved. Perhaps because of the reduced size of our party, the local natives began to drift in, shyly at first, soon with increased confidence and in greater numbers. We explained that we had come to get living birds of paradise, for which we were prepared to offer trade goods in exchange. Ward and Koi knew the words that represented most of the species we wanted, so that we had no difficulty on this score, though the natives showed little enthusiasm. But when we added that we also were in need of food, and offered them salt, trade tobacco and red calico, there was an immediate response. From that time on, we had a fairly constant, though small, supply of native sweet potatoes and squash-like pumpkins, which al-



Upper. A track in Mekeo. The country here is flat and stoneless, and during the dry season, the native paths are kept in excellent condition. This section lies between Inawaia and Inawaibui, and for miles is bordered by native garden land. *Lower.* A native dance in Mekeo. This was a social affair of importance, to which the village of Eboa invited the residents of ten neighboring communities. Such dances are continued, without interruption, for three or four days and nights.



The expedition's Mekeo headquarters, at Inawaia. Rest houses of this type are present in most Papuan villages, at least in the lowlands, for the convenience of passing patrol officers. In the adjoining cook house, a neat pile of earth serves as a stove.



The native dogs of New Guinea are of great interest. Although slender in build, they are of undoubted dingo type. The usual color is the yellow of the dingo, as in the dog at the left, although black ones are not uncommon. Most of the animals are pointed with white.



Papuan village pigs. These creatures are among the most treasured possessions of the natives. They are killed only on the most important occasions, usually at dances, when the meat is eaten by guests alone. Wild pigs abound in the bush and young ones are often captured and reared by the women. The species is distinguished as *Sus papuanus*.



This dilapidated police boys' house faced the rest house in Inawaia. It proved a most convenient shelter for our large collection of birds. Mr. Ward is seen engaged in the endless round of attention necessary to keep them in good condition.



Deserted boys' house or dubu, in Inawaia. While we were stopping in the village, one of the young men who lived in this house, was bitten by a snake. In spite of all we could do for him, including the injection of serum, he died. According to custom, the dubu was immediately deserted and left to fall into ruin.



Upper. A Mekeo burial. A bower of green palm leaves, about fifteen feet high, is erected and kept in place during the period of mourning. *Center.* In Mekeo, a great variety of lovely Croton and delicately scented Coleus plants, are cultivated with care, in little fenced gardens, close to the houses of the owners. The leaves are used for personal adornment. The patch of onion plants in the center of this garden is an ironic comment on the savage's reception of plants strange to him. *Lower.* A Mekeo grave, after the removal of the palm shelter. The body is carefully wrapped in bark and staked to the ground, the whole being covered with a mat of palm leaves.





Upper. A village constable of Mekeo. In each village of Papua that is under governmental control, an influential native is appointed constable or policeman, a policy that has greatly aided pacification. This individual is Opu Kaki, a character well known throughout Mekeo. *Lower.* The Mekeo village of Inawaia. Like most Mekeo communities, it is large and powerful. There are about twenty houses at each side of the street and the population was estimated at three hundred. The house in which the expedition made its headquarters is seen at the far end.



Upper. Bower of the fawn-breasted bower-bird (*Alphachlamydera cerviniventris recondita*). The bower proper is built on a mound of twigs, approximately four feet long, two feet wide and fourteen inches high. *Lower.* Another view of the bower-bird's play-house. The true bower is built near the middle of the mound, of finer twigs. It is about fourteen inches long, eleven inches high and ten inches wide. This bower was decorated with three varieties of small green fruits.



Fawn-breasted Bower-bird. *Alphachlamydera cerviniventris recondita* (Meyer).
Adult Male.



Upper—Twelve-wired Bird of Paradise. *Seleucides ignotus* (Forst). Adult Male.
Lower—Lawes' Six-plumed Bird of Paradise. *Parotia lawesi lawesi* Ramsay. Adult Male,



Lesser Superb Bird of Paradise. *Lophorina superba minor* Ramsay.
Adult Male.



Lesser Superb Bird of Paradise. *Lophorina superba minor* Ramsay.
Adult Male.

lowed us to reduce consumption of our own scanty supplies.

For some days, there was no action as far as birds were concerned. Then, early one morning, a small boy brought us a large white-throated pigeon,[1] which is now happily dwelling in the Zoological Park. He received in exchange a beautiful trade knife with shiny brass rings in the handle, which caused his eyes to pop with admiration. The glad news must have spread, for just after noon, we received our first bird of paradise, a female six-plumed.[2] Soon afterward, a female lesser superb[3] was brought in. We duly rewarded the captors with the coveted knives but explained that we wanted males.



Koi, cook-boy and interpreter.

By the next day, the whole region was astir and a constant stream of natives came and went, bringing us birds of paradise and carrying away their booty. Beyond doubt, they considered us quite mad and certainly they never had the slightest glimmer of the reason for our seeming insanity. In no time, our eight box cages were crowded with lovely six-plumes, the deep velvet black of their plumage set off by the brilliant blue of their eyes and the silver patches at the bases of their beaks; shimmering little lesser superbs, with great shining green crescents on their breasts and heavy black capes over their backs; brilliant magnificents, with bright green breasts, and backs of yellow and maroon, that always seemed to be just out of pattern. Soon we could take no more of these but when natives brought them long distances, as they continued to do, we bought the birds and let them go. They always were overcome with chagrin when the captives seemed to slip from our fingers and escape into the bush.

We now concentrated on Prince Rudolph's blue bird of paradise,[4] which we knew was found here and was one of the main objects of the expedition. The natives showed a curious reluctance to catch this species, either from some superstitious fear, or simply because the birds live far up the sides of steep-sloped mountains. To reinforce our arguments, we displayed the shining trade axes, which until now we had held in reserve. We had expected to get Count Raggi's bird of paradise, with its fine red plumes, without much trouble, but it appeared to be difficult and none had been brought in. We therefore increased its value to that of an ax, and included, as a forlorn hope, the long-tailed bird of paradise,[5] the largest and finest of all the family, which we had no real expectation of getting.

Whatever may have been the cause for hesitation, the offer of real steel axes quickly overcame it and soon we had word that "All boy he go bush!" A day or two later, the first blue came in, borne by a diminutive messenger, who stated that the captor was remaining in the field, in hope of getting another. It was a magnificent creature, finer and more brilliant by far than any living specimen or skin I had

[1] *Columba vitiensis halmaheira.*
[2] *Parotia lawesi lawesi.*
[3] *Lophorina superba minor.*

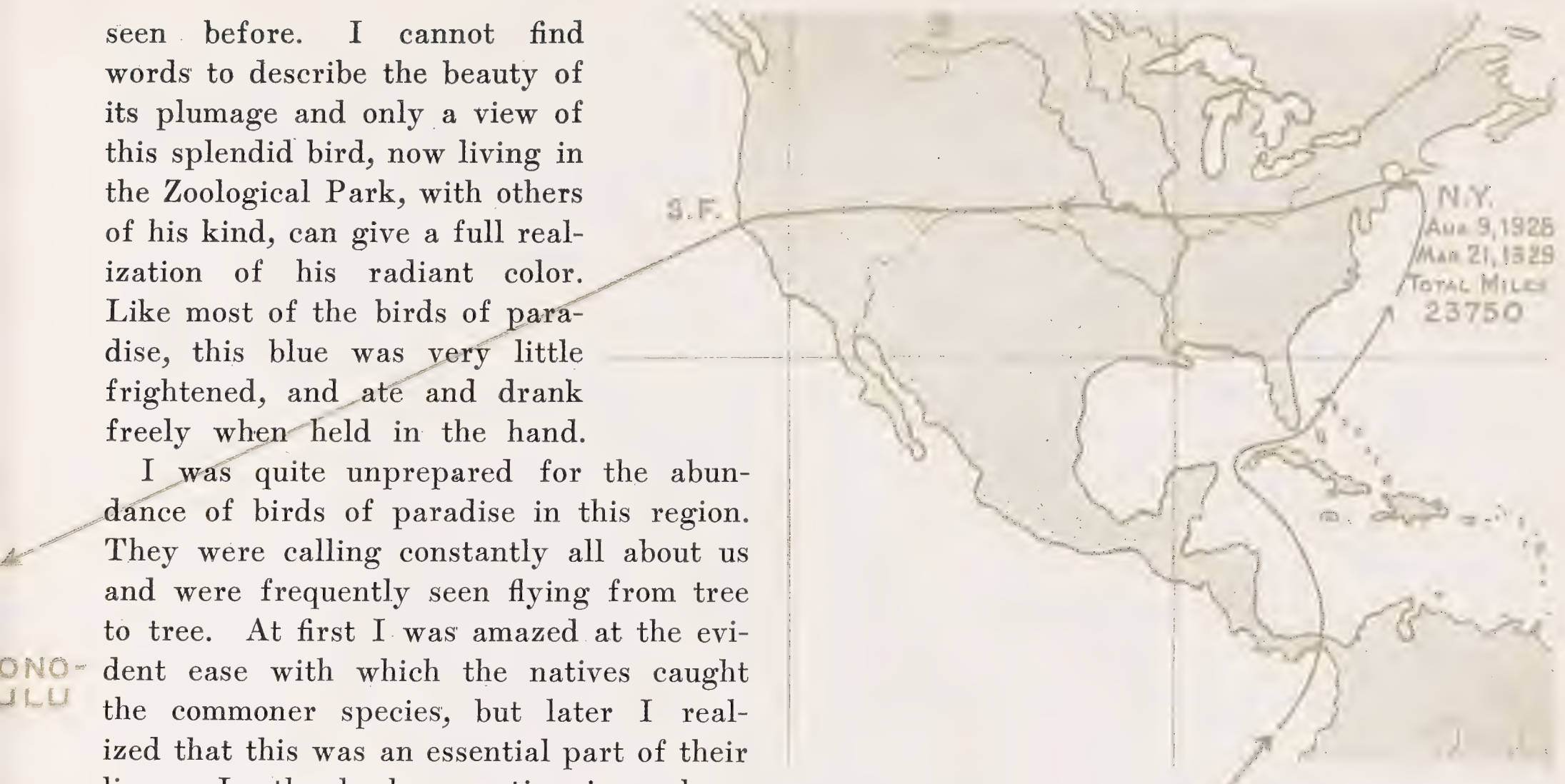


[4] *Paradisornis rudolfi.*
[5] *Epimachus fastosus meyeri.*

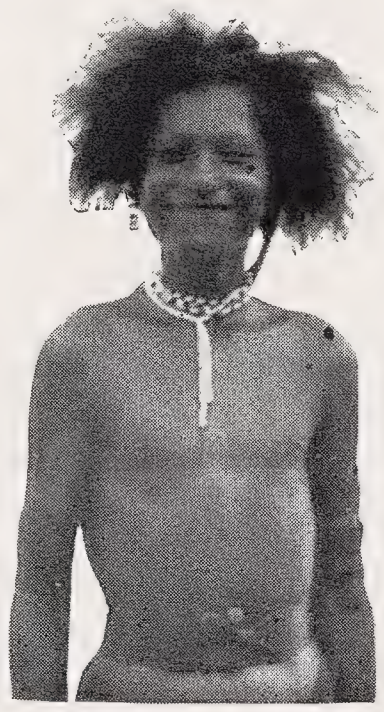
seen before. I cannot find words to describe the beauty of its plumage and only a view of this splendid bird, now living in the Zoological Park, with others of his kind, can give a full realization of his radiant color. Like most of the birds of paradise, this blue was very little frightened, and ate and drank freely when held in the hand.

I was quite unprepared for the abundance of birds of paradise in this region. They were calling constantly all about us and were frequently seen flying from tree to tree. At first I was amazed at the evident ease with which the natives caught the commoner species, but later I realized that this was an essential part of their lives. In the bush, a native is as keen and sensitive as a hunting animal, to sound and smell. Nothing escapes his notice. In a given territory, he knows where each bird has its home—where it sleeps, where it feeds, where it displays. Except at certain seasons, when the birds are irregular in habits, he can catch them almost at will.

Mountain people, throughout New Guinea, do an extensive trade in paradise plumes, with the coastal tribes, receiving in exchange pots, shell ornaments, lime, cocoanuts, and other valuables. Many tribes, skilled in the use of bow and arrow, secure the birds by this means. But in those parts of the Central Division with which I am acquainted, the bow and arrow are unfamiliar weapons and the native does his catching with snare and net, usually taking the birds uninjured. He may set a snare in a feeding tree or over a bait of fruit, holding the free end perhaps for hours, waiting for the moment when a quick jerk will secure the bird he wants. Or he may use a net, skilfully woven of excellent cord made from the inner bark of a tree, placed in such a manner that the bird will fly into it and be seized before it can escape. No white man could hope to equal a native, working in his own district, at such a task. Catchers taken from one section to another are too much frightened to work well, so that the collecting of living birds of paradise in a bow and arrow district is a difficult matter.



After the first blue, there was a cessation in arrivals and in order to attempt to enlarge our field of operations, it was decided that I should take two boys and proceed to the Mafulu country, which lies higher in the mountains, to the northeast. It was impossible for Ward to spare Koi, as his services as interpreter were necessary. Consequently, I was compelled to choose two whose loyalty had been demonstrated chiefly by their actions, since they had only a word or two of English and Motu between them. As we were unable to exchange ideas, I could not understand the care with which they guarded me on the trip—two hens with one chick could not have been more solicitous. Later, I learned from Ward that he had warned them, before we started, that if any harm should come to me, he would give them both a hiding!



Aya, one of the bird-boys.

We followed the track from Deva-deva, straight down the mountain to the Aya River, followed by a heart-breaking climb up the other side, broken by sharp elbow turns, numbering close to twenty. New Guinea boys never stop on the track until they come to the



Count Raggi's Bird of Paradise. *Paradisaea apoda raggiana* Sclater.
Adult Male.



Count Raggi's Bird of Paradise. *Paradisaea apoda raggiana* Sclater.
Adult Male.



Prince Rudolph's Blue Bird of Paradise. *Paradisornis rudolfi* Finsch.
Adult Male.



Prince Rudolph's Blue Bird of Paradise. *Paradisornis rudolfi* Finsch.
Adult Male.



Mountain panorama from Dilava. Because of the density of the forest, it is seldom possible to obtain an unobstructed view. Even then, this is possible only very early on clear mornings, before the mists begin to rise. The large mountain at the right is Virjus Dome.

top, no matter how steep. In order to avoid the loss of prestige which must result from any show of weakness, I had to struggle on, though I would gladly have given any lesser price for a moment's breathing space. We finally reached the summit and could look down into the great valley of the Aduella River or, as it is called by the Mafulu people, the Auga. There were large patches of open grass country visible, though I took this to be saw grass, similar to that of Mekeo. If so, it would be far more difficult to traverse than any bush country. Perched high above, on a jutting spur, stood the outlying Mission station of Popole.

I judged the distance from Deva-deva to Popole to be no more than ten miles, but it took us three and one-half hours to cover it and I, for one, was not sorry when we reached the station. I was kindly received by Father Dontenwill, the resident missionary, who had occupied his solitary post for twenty years or more. After a hearty and more than welcome lunch, we went on about four miles to Taruve, the nearest village to the Mission. We had a rather embarrassing time here, as neither the boys nor myself could speak a word of Mafulu and we had no interpreter. To make things worse, both boys were badly frightened, as the Mafulu people have an unsavory reputation. However, we found that a dance was just ending and that among the guests was a native who could speak Motu. Through him, we managed to explain the reasons for our coming and to urge that birds be brought or sent to us. I received full assurance of cooperation but realized that nothing would come of it, since there were pigs to be killed and I knew no one would leave the village as long as a scrap remained. Moreover, in the light of present knowledge, I am quite sure that no Mafulu native would have ventured into the Deva-deva country for any such purpose.

I assuaged my feeling of disappointment by exposing all of the motion picture film I had brought, bought at least a bushel of sweet potatoes for the boys for a few sticks of tobacco and some matches, and departed. After another excellent meal at Popole, I was glad to seek the

cot assigned to me for the night. I was very tired after my eighteen miles of rough going and the cot was a pleasing change from the knotty poles of Deva-deva.

Next morning, while enjoying my third nearly civilized meal, I felt very sorry for Ward, forced to subsist on the thin fare of Deva-deva. This feeling grew naturally into the thought that my two boys should take with them the remains of the bushel of potatoes, in case of a not improbable shortage at our camp. I found, however, that they had consumed the lot, a feat of which they were quite capable.

After expressing thanks for the hospitality of Father Dontenwill, we set out for Deva-deva, arriving well before noon. I found that Ward had received another blue bird of paradise, a pair of Count Raggi's and a beautiful black-headed catbird.[1] During the afternoon three more blues came in, as well as a female long-tail, a great prize.

[1] *Ailuroedus melanotus melanocephalus.*

We now had more birds than we really had room for and devoted the next few days to making reed cages, which the boys skilfully tied together with strips of bark. More blue birds came in, and at the last moment, a grinning native brought us another long-tail, which proved to be an immature male.

One day about noon, loud shouts were heard from down the track and a procession appeared, which turned out to be our rice carriers, who had exceeded out expectations by actually returning. Moreover, they had eaten only ten pounds of rice on the journey, had brought us two bunches of bananas, which they knew we needed for our birds, and had recruited four new carriers. Each boy received double pay for the eight days' journey and the venture was voted a complete success.

With our new supply of rice, it was evident that we had a chance to get through in a dash for Mekeo. However, it was three days before we could get the thirteen mountain boys needed



Mount Iola, as seen from Deva-deva. There are two peaks, one directly behind the other, bearing twin villages, also known as Iola. A large garden patch is seen on the lower slope. Iola is within shouting distance of Deva-deva, but visiting natives had a long walk to get to our camp.



A native garden at Deva-deva. Mountain natives seem invariably to live on the higher spurs, making their gardens on the slopes below their homes. The constant heavy rains and steep inclines make the soil difficult to hold. The cross barriers in this garden seem to indicate a primitive idea of terracing.

to complete our team of carriers, which meant a serious drain on our rice. After two days on the track, when we had reached a point known as Dieni, we found that food for both men and birds was practically exhausted. We were three days' proper march from Inawaibui, the nearest village, and there seemed nothing to do but try to get through in one day. We estimated the distance at about thirty-five miles, which seemed to me impossible to cover. However, we were astir before dawn next morning, divided the last of our rice and hard biscuits between ourselves, the birds and the boys, and set out in the first gray light. We made good time in the early coolness, but later, in the full heat of the day, we began to lose pace. Late in the afternoon, the boys began talking about the "big water," to which the little-used bush track we were following would soon bring us. They evidently looked forward to it without pleasure and I soon found their feeling was justified. The "big water" was an opening through the reeds of the great Bioto swamp, half a mile long, which was crossed on single three-inch poles, laid end to end, three feet under water. They were supported in forks formed by sticks thrust into the roots of the reeds on either side, and hand-poles were provided at long intervals in a similar manner. How the boys managed to get over with their loads I never knew, for they made the crossing before us. Two stopped behind to help Ward and me, and their assistance was needed.

Half an hour later, we came out on the Bioto track, two miles from Inawaibui. Here we found our party, sprawled among the bird boxes, devouring bananas. We rushed to our birds and found them gorging, as well. The explanation of this miracle was had from Koi. One of our boys, who lived in Inawaibui, had gone to his garden nearby and found a bunch of fruit ripened on a tree, carefully wrapped in leaves to protect it from birds and flying foxes. In New Guinea, one hears much of the laziness and uselessness of natives but the events of this day had put them in an entirely different light to me.



Mount Kebea. This lovely mountain, which has an altitude of about 6,000 feet, lies between Matsika or Valya, and Deva-deva. The track zigzags along the side of the mountain and it was here that we saw the first six-plumed bird of paradise. Kebea appears to represent the southwestern limit of the blue bird of paradise.



The headquarters of the expedition at Deva-deva. The shelter in the center is the patrol officers' house; the one at the left is for carriers; that at the right for native police. It was here that we gathered most of our birds of paradise. The tall trees with palmate leaves are bread-fruits.

Having refreshed ourselves, we made the short distance to the village with flying colors, and soon were established in the local rest-house, our birds slung underneath. There were plenty of bananas, pawpaws, taro and sweet potatoes to be had, and all joined in a tremendous meal. Next morning, we took stock of our birds, now somewhat recovered from their ordeal. We found that, for the most part, they had come through wonderfully well.

Rested after our night's sleep, we set out on the eight miles to our base in Inawaia, our feet flying over the flat Mekeo track, which was like a city pavement after what we had been through. Just outside the village, the boys stopped to comb their hair and decorate themselves with what leaves and flowers the bush offered, for they were too proud to be seen at the end of a long march in dishevelled condition. I took advantage of the opportunity to run ahead of them and set up my little motion picture camera, so that I could film them as they entered the village, bearing their heavy burdens with a lightness and grace I knew was largely bravado.

After two weeks of hard work in Inawaia, getting our birds back into condition and adding to our collection of lowland species, it was decided that I should go back into the middle mountains to try my luck. I was to take Koi and recruit ten boys for carriers, and Ward was to remain in Inawaia and look after the collection. This time, there was no difficulty in getting volunteers and I chose ten of the crowd that was willing to go. I knew all of these boys well and we were soon on a basis of comradeship ordinarily difficult to maintain with natives. They were constantly on the alert for my safety and comfort but never attempted to take undue advantage. Travelling light, we easily covered, the first day, a distance that usually requires three. Early morning of the third day found us established in a tiny mountain hamlet of four houses, called Kekefi. It was perched on a sharp spur facing almost due north. Across the valley, I could see the granite sides of Virjus Dome, with the Needles just beyond and the great crest of Mt. Yule, more than 10,000 feet high, rearing itself from the mists in the distance.

I sent back four carriers, so that we would not be too much of a drain on the local sweet potato gardens and settled down to await the birds I was sure we should get. Koi and I shared a tiny dubu with a hospitable native, who suffered from double cataract, and the six boys made a rude shelter for themselves.

My aneroid showed the elevation to be 2,350 feet. Count Raggi's and magnificent birds of paradise, as well as the magnificent rifle bird, were abundant. The people assured me that there were plenty of king birds of paradise on the lower slopes of the mountains and that they would have no difficulty in getting them. However, several days passed, and while I had some lovely little fruit pigeons and black and chestnut shrike-thrushes, I received no birds of paradise. The would-be catchers finally admitted what I believed to be the truth—the birds were not dancing at that season and the only fruit at which they could be caught had just finished.

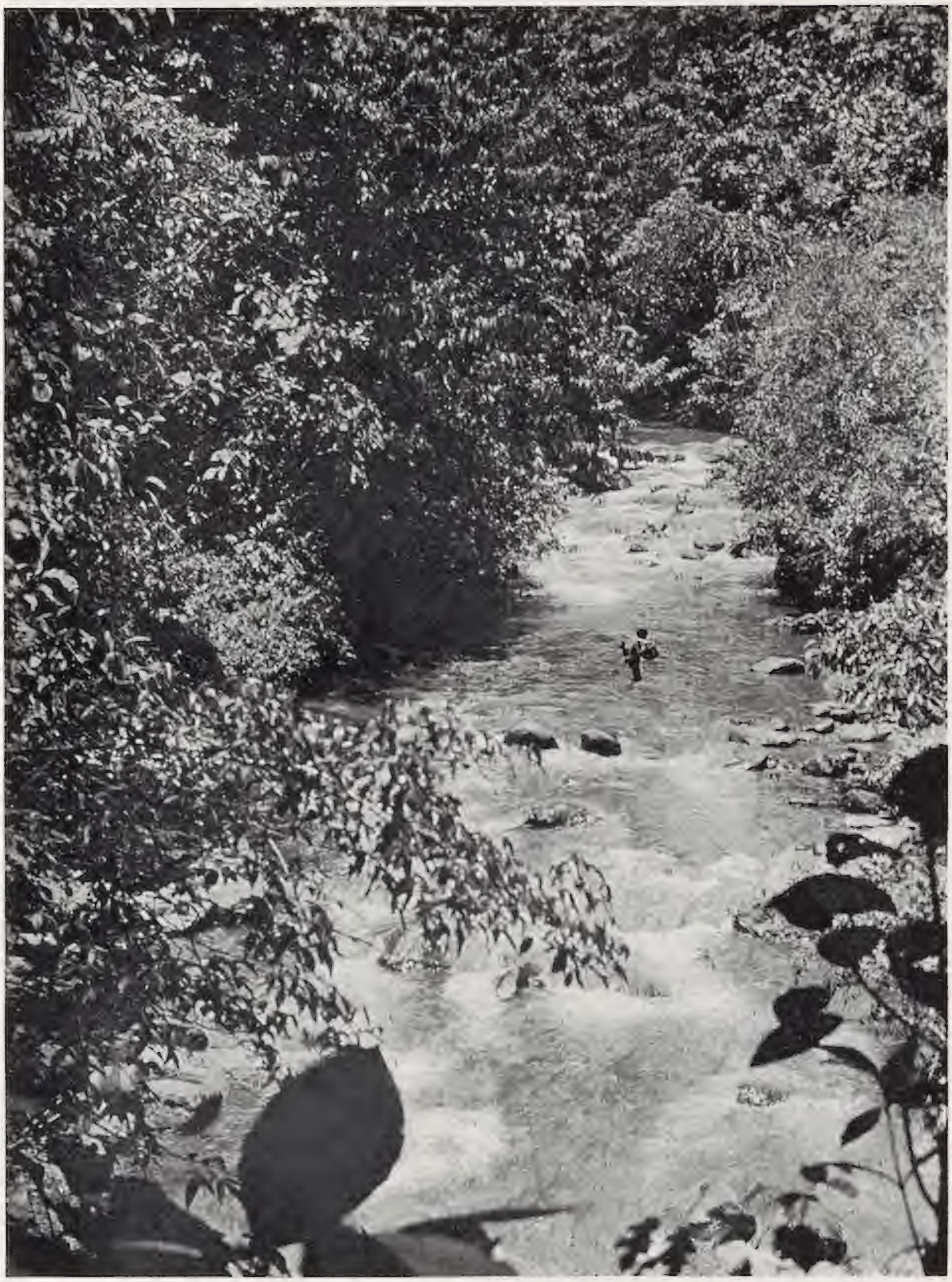
Realizing that further waiting was useless, we settled accounts with our friendly hosts and set out for Inawaia with what birds we had. We covered the distance this time in two days but not without some discomfort to myself, as I strained a knee-ligament early in the march and walked with difficulty. I found Ward well and happy, with numerous additions to the collection.

The time for the Morinda's bi-monthly call at Yule Island was drawing near, and we must leave with her or be caught by the impending rains. Angabunga Plantation, Mekeo's only commercial enterprise, lies about six miles from Inawaia, west of the river. Mr. N. G. Ducker, the manager, was planning to transport his copra to Arure, his station on Yule Island, for shipment on the Morinda. In spite of great inconvenience to himself, he agreed to allow us to fill a half-empty punt with our bird boxes. This was no small favor, for it saved us a walk of twenty-five miles or more, a march for which we should never have secured sufficient carriers. As it was, we had to muster most of the male population of two villages, well over eighty being required to carry our now formidable accumulation of boxes to the landing.

Running with the swift current, we made excellent time, and except for the usual excitement in passing snags and sand bars, the trip was uneventful. We reached the mouth of the



Upper left. Deva-deva native holding a gardener bower bird. This species is frequently caught for its decorative golden crest. *Upper right.* A six-plumed bird of paradise is brought in. This man's companion was severely injured in a fall from a tree, which accounts for his carrying two axes. *Lower.* Our first blue bird of paradise. While all of the species ate readily when held in the hands, the blue were particularly docile and took to their new lives without making the least trouble.



The Aya River. This river runs almost directly north, through the deep valley which bears its name. It must be crossed in going from Deva-deva to Mafulu. The carrier who is in the water, lost his footing and dropped a camera in the swift current. Fortunately, it was recovered without damage.



View from Popole, in the Mafulu district. The mountains shown are in the Ambo country, which lies to the north, across the Auga. The natives are not under control and in recent years have attacked several patrol parties.

river at high tide, managed to scrape across the barrier into Hall Sound and soon were safely at Arure. For five days, we enjoyed the hospitality of Mr. and Mrs. Ducker, our birds comfortably stowed beneath the kitchen of their boys' house.

On December 9, for the first time in seven years, the *Morinda* entered Hall Sound far enough to anchor off Arure. Between punt loads of copra, we got our boxes of birds aboard and safely stacked under a shelter on the tiny poop-deck. Ward and I experienced a feeling of great relief and congratulated ourselves on the end of our troubles. We had only to sit tight, look after our birds and presently we should arrive, quite comfortably, in Sydney.

We spent the next day in Port Moresby, making official adieus and exhibiting our fine collection with pride. The *Morinda* sailed that night for Samarai, the second town of the Territory, situated at the extreme eastern end of the Island. About seven the next morning, as we were working on our birds, the ship gave a slight shudder and her engines stopped. We rushed to the rail and found that she was fast on a coral reef, which could be seen distinctly through the clear water. The engines were reversed, in an attempt to back the ship out as she had come in but this proved to be of no avail. We were about five miles off shore, at a point known as Dedele and did not feel that we were in any particular danger. However, the southeast trade wind stiffened, and as we were outside the barrier reef, we took the heavy seas full on our beam. The ship soon began to pound heavily on the reef, with the result that our cages could hardly be kept in position and their occupants were being badly shaken up. Two days later, the schooner *Matona* arrived from Samarai and removed a few tons of freight and our thirty passengers. For our birds there was no room, so we were unable to go.

On December 16, five days after the *Morinda* had struck, the steamer *Montoro*, called from Rabaul, arrived on the scene. After a

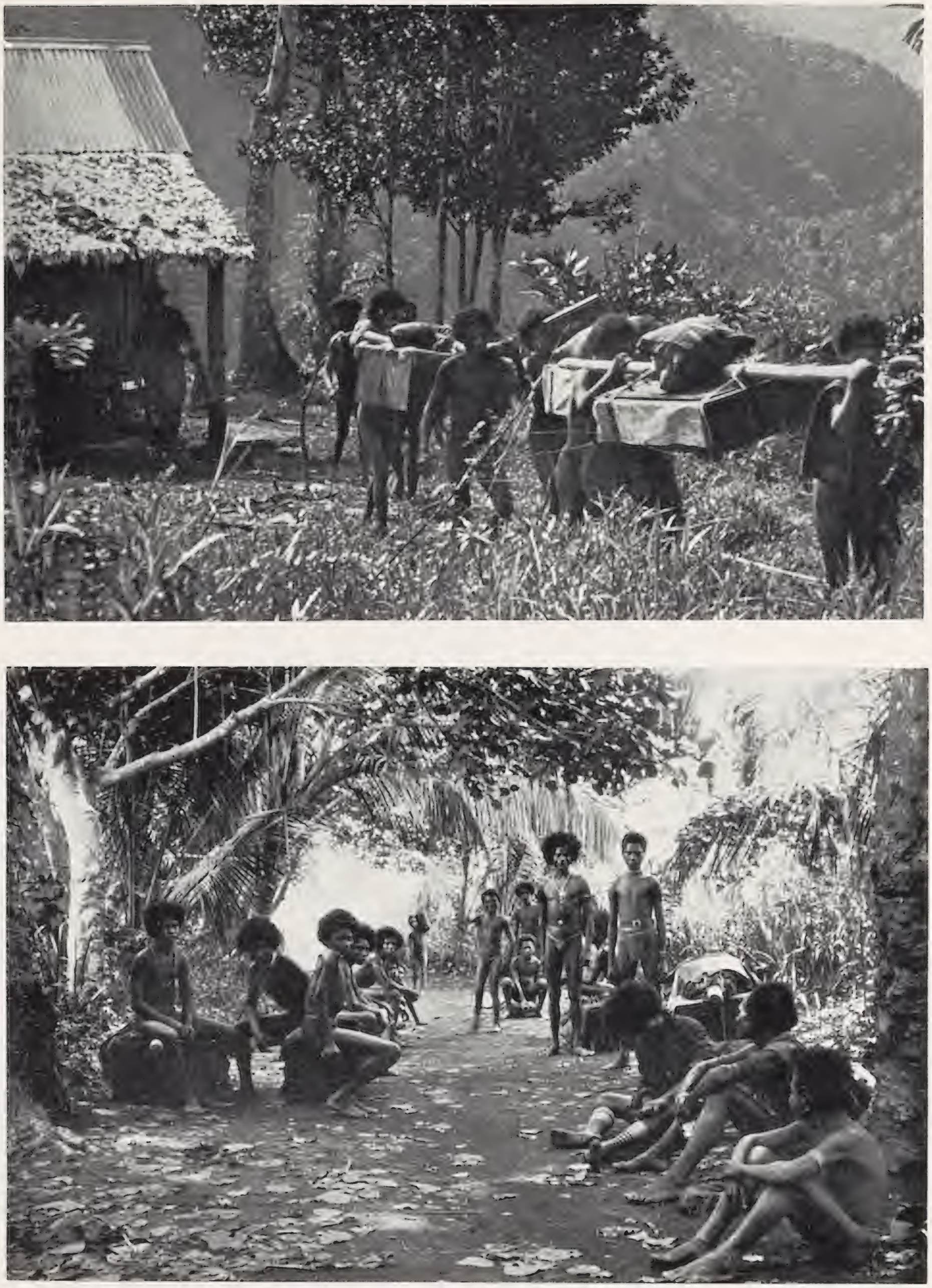


This beautifully symmetrical peak is just opposite the Mafulu village called Taruve, the most distant point to which the expedition penetrated.





Upper. The village of Taruve, in the Mafulu district. The plan of construction is quite different from that of Mekeo villages. All of the houses are small, and set closely together, forming an oval. The village can be entered only by climbing the bars at the left of the house shown in the center. *Lower*. A dance had just ended in Taruve and the invariable feast was about to take place. The houses are decorated with viands, including various fruits, yams and bark-wrapped bundles of smoked wallaby meat.



Upper. Our carrier train leaving Deva-deva for the long march to the lowlands. The boxes of birds made bulky and cumbersome loads. The usual method of carrying in Papua is well shown. *Lower.* A rest on the track. The expedition is safely back in Mekeo, after a strenuous and successful effort to save our collection of birds from loss through lack of food.



The *Morinda* fast on Dedele reef. Early on the first morning out from Port Moresby, on the return journey, the *Morinda* struck on the unyielding coral and was unable to free herself.

futile attempt to haul the *Morinda* into deep water, she took off the remainder of the freight and finally, ourselves. It was agonizing to see our bird boxes go over the side in slings, dropped helter-skelter into punts. Finally, they were landed, in the same manner, on the deck of the *Montoro*—cages upside down, slides smashed, food and water tins flying. When we had got them below and into some semblance of order, we were amazed and relieved to find that no harm had been done.

We proceeded to Samarai, back to Port Moresby and finally to Sydney, arriving on December 26. In spite of the unexpected delay and hardship, from Yule Island to Sydney we had lost nothing and our birds were landed in perfect condition.

Mr. Ward, at a considerable sacrifice to himself, placed his spacious Balmain aviaries at my disposal. Here our birds enjoyed rest and freedom for nearly six weeks, as there was no suitable ship leaving for New York. We passed the time in preparation for the long voyage, I over-hauling box cages, while Mr. Ward constructed a number of new ones, which proved excellent in practise.

One morning, our finest blue bird of paradise, the first one we had obtained at Deva-deva, escaped from a small cage in which he had been placed temporarily. We were able to follow him for a time, as he flew strongly from tree to tree, but we soon lost track of him. In spite of offered rewards, we could learn nothing of him and finally gave him up as definitely lost. Five days later, while working in the aviary, I was amazed to see our beautiful blue hanging on the outside of the wire, evidently looking for an entrance. I ran for Ward and presently we had baited a parrot cage with fruit, a string on the open door. In no time the delinquent was in his box, glad to be back where food and water were plentiful.

On February 6, I sailed for New York on the freighter *Canadian Cruiser,* sturdy flag-ship of the Pacific fleet of the Canadian National Steamship Line. Ernest Ward, Mr. Ward's



Soon after the *Morinda* had struck, the southeast trades sprung up. As she lay on the seaward side of the reef, she was fully exposed to the heavy seas and was subjected to a severe pounding.



Two days later, the 100-ton schooner *Matona* came up from Samarai. Our passengers and some valuable freight were taken off but there was no room on the overloaded schooner for our birds.

son, had managed to get leave from his government position, to accompany me. Our collection had been considerably enlarged by Australian specimens. Many of these were acquired by purchase, but Mr. Ward, by means of much hard work, managed to gather an excellent lot of the smaller species, not otherwise obtainable. Through the courtesy of the steamship officials in Sydney, we had secured a disused smoking room on the ship for our birds, with comfortable quarters for ourselves adjoining.

The voyage to New York, stopping only at Panama, required forty-four days, a long haul for our birds. However, we had started from Sydney with forty birds of paradise and when, on the warmest March 21 in many years, the *Canadian Cruiser* nosed her way to her berth in Gowanus Creek, South Brooklyn, the forty remained alive and well.

* * *

Since their arrival at the Zoological Park, the birds of paradise have continued to thrive, completing the molt that was then in progress. All of the adult males are now in full, brilliant plumage. The collection occupies the entire tier of cages along the north side of the Main Hall of the Large Bird House, where, throughout the summer and autumn, they were admired by great crowds of visitors. Of Prince Rudolph's blue bird of paradise, we have retained only two pairs, the three others, with several six-plumes, having been presented to the Zoological Gardens of Philadelphia, Washington and Milwaukee. The two remaining male blues are in almost constant display during the hours of daylight, hanging heads down from their perches, spreading their gorgeous colors without the slightest show of fear.[1] The deep red plumes of Count Raggi's bird of paradise may be compared with the golden yellow ones of the greater, a specimen of which we have had since 1926. The shining green breast plates and spreading hood of the lesser superb may be seen to ex-

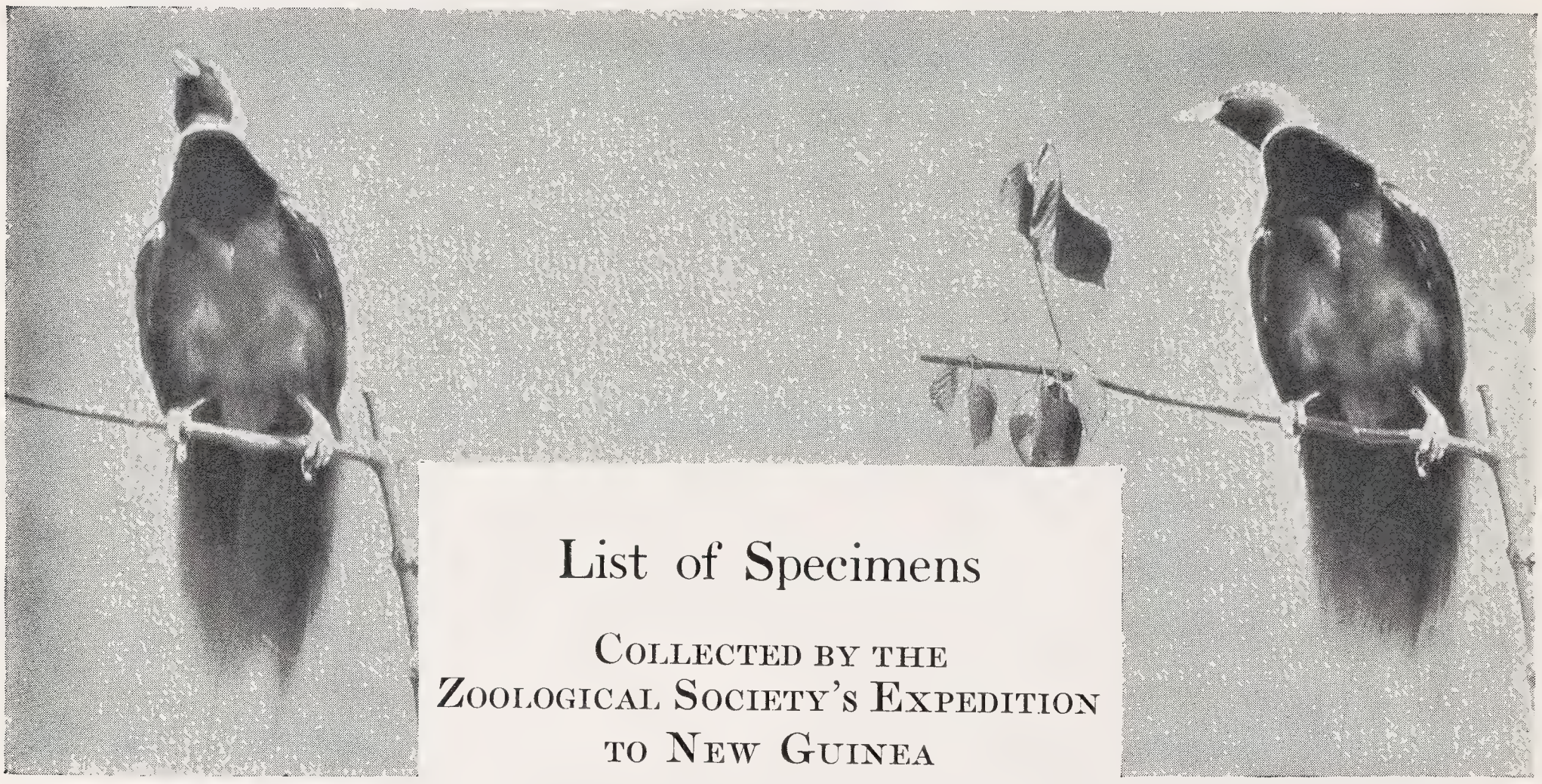
[1] A full description of the display of the blue bird of paradise, with a colored plate, was published in the Bulletin for September, 1921.



After five days of real hardship for our birds, the steamer *Montoro*, called from Rabaul, arrived on the scene. Our collection was transferred without mishap and finally reached Sydney without loss.

cellent advantage and a six-plumed may be detected at his curious dance, body plumage extended like a feathered umbrella, head plumes waving. That this display of beauty is appreciated by our visitors is evidenced by the numbers who enjoy it daily.

To cover the cost of the Expedition, the sum of $12,000, from the funds of the Zoological Society, was allotted by the Executive Committee. The total expenditure, including the final preparation of five reels of motion picture film, was within this amount.



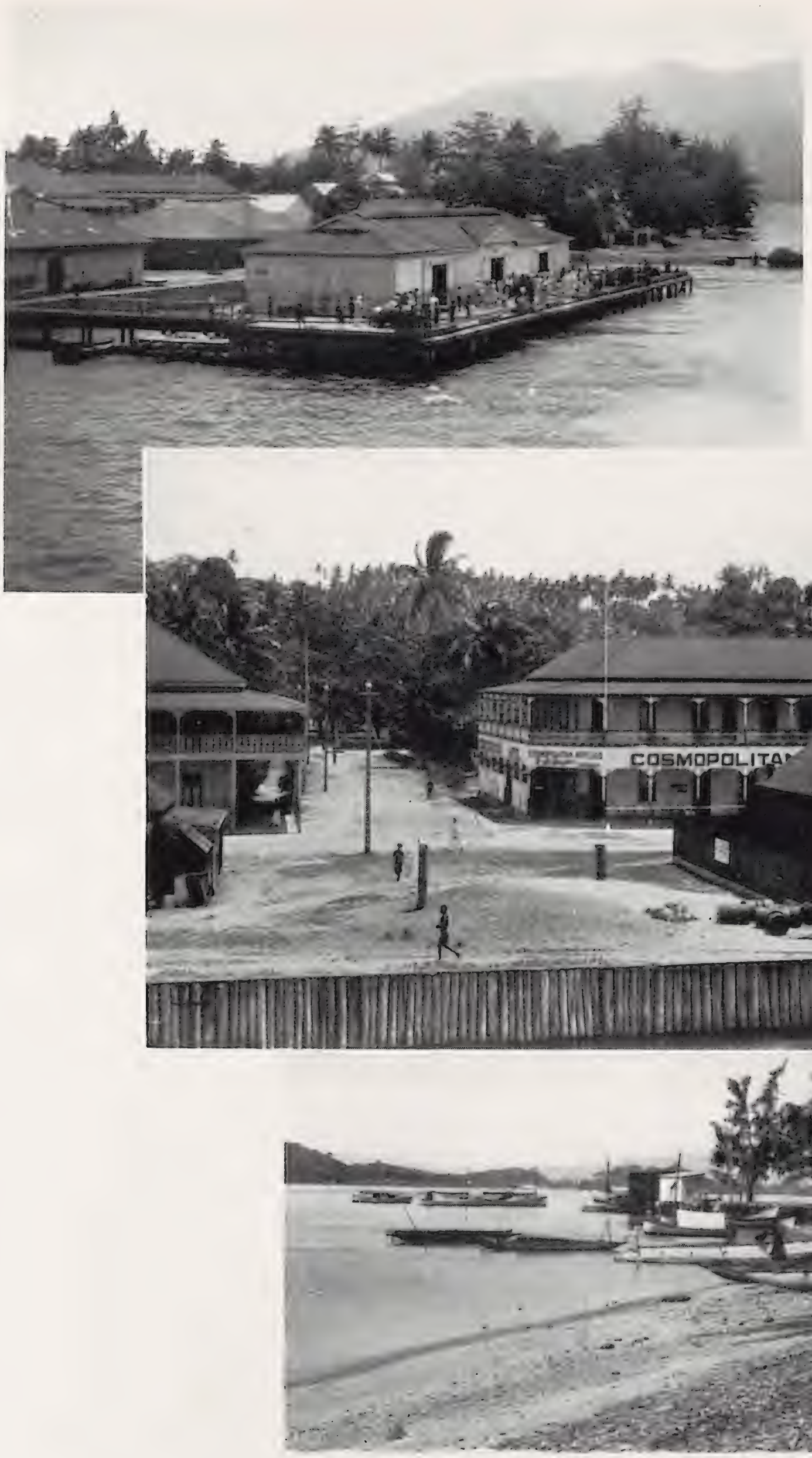
List of Specimens

Collected by the Zoological Society's Expedition to New Guinea

The Expedition left New York on August 9, 1928, *and returned March* 21, 1929, *with forty birds of paradise, of nine species, about* 200 *other birds and several mammals. The list includes a number of rare Australian species secured on the return of the Expedition to Sydney.*

16 Lawes' Six-plumed Birds of Paradise..... *Parotia lawesi lawesi*
2 Long-tailed Birds of Paradise..... *Epimachus fastosus meyeri*
6 Lesser Superb Birds of Paradise..... *Lophorina superba minor*
1 Hunstein's Magnificent Birds of Paradise.... *Dyphyllodes magnificus hunsteini*
2 Count Raggi's Birds of Paradise..... *Paradisaea apoda raggiana*
7 Prince Rudolph's Blue Birds of Paradise.... *Paradisornis rudolfi*
3 Horned Manucodes ..... *Phonygammus keraudrenii jamesi*
2 Black Manucodes ..... *Manucodia ater alter*
1 Blue Manucode ..... *Manucodia chalybata orientalis*
1 Black-headed Catbird ..... *Ailuroedus melanotus melanocephalus*
1 Fawn-breasted Bower-bird ..... *Alphachlamydera cerviniventris recondita*
1 New Guinea Friar-bird..... *Philemon novaeguineae brevipennis*
2 Dumont Mynas ..... *Mino dumontii dumontii*
10 Purple Glossy Starlings ..... *Aplonis metallicus metallicus*

2 Green Glossy Starlings.....*Aplonis cantoroides cantoroides*
2 Gray-headed Mannikins .....*Munia caniceps*
8 Parrot Finches .....*Erythrura psittacea*
2 Gouldian Finches .....*Poephila gouldiae*
8 Chestnut-breasted Mannikins .....*Munia castaneithorax*
6 Diamond Finches .....*Steganopleura guttata*
3 Cherry Finches .....*Aidemosyne modesta*
2 Bicheno Finches .....*Stizoptera bichenovii bichenvoii*
4 Sydney Waxbills .....*Aegintha temporalis*
4 New Guinea Pittas.....*Pitta atricapilla*
1 Chestnut Shrike-thrush .....*Pitohui dichrous monticola*
4 White-rumped Wood Swallows.....*Artamus leucorhynchus leucopygialis*
6 Yellow-breasted Robins .....*Eopsaltria australis australis*
6 Superb Blue Wrens.....*Malurus cyaneus australis*
6 Australian White-eyes .....*Zosterops lateralis lateralis*
6 Black-and-white Fantail Flycatchers.....*Leucocirca tricolor tricolor*
2 Wonga-Wonga Pigeons .....*Leucosarcia melanoleuca*
1 Reinwardt Pigeon .....*Reinwardtoena reinwardtsi griseotincta*
1 White-throated Pigeon .....*Columba vitiensis halmaheira*
6 Brown Pheasant-pigeons .....*Macropygia amboinensis cinereiceps*
2 Blue-billed Pheasant-pigeons .....*Macropygia nigrirostris*
7 Golden-headed Fruit Pigeons.....*Sylphitreron ornatus gestroi*
4 Painted Fruit Pigeons.....*Ptilopodiscus coronulatus coronulatus*
1 Superb Fruit Pigeon.....*Ptilinopus superbus superbus*
1 Lilac-shouldered Fruit Pigeon.....*Chlorotreron iozona iozona*
2 Red-crowned Fruit Pigeons.....*Ptilinopus pulchellus pulchellus*
8 Yellow-heart Pigeons .....*Gallicolumba rufigula rufigula*
1 Black-fronted Amethyst Pigeon.....*Gallicolumba jobiensis*
1 Bustard-Pigeon .....*Otidiphaps nobilis cervicalis*
8 Stephanie's Pigeons .....*Chalcophaps stephani*
3 New Guinea Green-winged Pigeons .....*Chalcophaps indica chrysochlora*
7 Red-necked Rails .....*Tomirdus tricolor grayi*
2 Australian Stone Plovers.....*Burhinus magnirostris magnirostris*
2 Giant Laughing Kingfishers.....*Dacelo gigas gigas*
4 Blue Grass Parrakeets .....*Melopsittacus undulatus var.*
2 Cobalt Grass Parrakeets.....*Melopsittacus undulatus var.*
4 Barraband Parrakeets .....*Polytelis swainsonii*
4 Yellow-rumped Parrakeets .....*Platycercus flaveolus flaveolus*
2 Mealy Rosella Parrakeets.....*Platycercus adscitus palliceps*
2 Barnard Parrakeets .....*Barnardius barnardi*
4 King Parrakeets .....*Alisterus cyanopygius*
1 Blue Bonnet Parrakeet.....*Northiella haematogaster xanthorrhoa*
4 Crimson-winged Parrakeets .....*Aprosmictus erythropterus*
2 Blue Mountain Lorikeets.....*Trichoglossus novaehollandiae*
2 Echidnas .....*Echidna hystrix*
2 Great Red Kangaroos .....*Macropus rufus*
1 Agile Wallaby .....*Macropus agilis papuanus*



Upper. Leaving the wharf at Samarai. Situated at the extreme southeastern end of Papua, Samarai is the second town of the Territory. It is a lovely spot, set in delightfully tropical surroundings. *Center.* In spite of its secondary importance from a governmental point of view, Samarai enjoys far better shipping facilities than does Port Moresby. On steamer days, at least, it presents an air of business-like activity. *Lower.* The harbor at Samarai is particularly beautiful. This is a native section, where the outrigger canoes are drawn up on the beach.



Long-tailed Bird of Paradise. *Epimachus fastosus meyeri* Finsch.
Immature Male.

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